Radio and Electronics

OUR COVER

This month is shown a radar chart comparator, which by optical means superimposes a view of a navigator's chart directly on the radar display, making comparison of the two very exact, and easy to carry out. This device is greatly adding to the usefulness of ship-borne radar, and has been installed on many British ships.

●

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Radio As A Hobby

For many years now, radio has been used as a spare-time occupation or hobby by countless thousands who feel the need for something which will occupy both their minds and hands. The fact that it satisfies this need whatever one's manual or mental ability is probably the greatest reason for its success in this direction. But frequently, these days, one hears complaints that radio, as a hobby, is not what it was.

We could not agree more. Thirty years ago, for example, it was very different, as even the briefest glance at a periodical of the day will convince anyone. Everything was much simpler in the "good old days," when the range of available valves, for both receiving and transmitting, was small enough for the types to be numbered on the fingers; when the range of commercial components was very small; when the amateur constructor had to improvise much of his own equipment, or go without; and when even the dyed-in-the-wool expert knew only a small fraction of what a relatively unqualified man knows today, because the sum total of radio knowledge was then so much smaller than now. As well as possessing simple equipment, the 1920s had fewer difficulties, in some ways. There was very little interference, compared with what we have to put up with now, so that from the man who merely twiddled the knobs of his newly-purchased broadcast receiver, to the amateur transmitter and the communications engineer, reception was in this respect a much easier problem. Very high frequencies had been generated in laboratories, but in very few other places. Reproduction of speech and music was exceedingly poor as judged by modern standards, but was wonderful nevertheless. We had still not ceased to marvel at the miracle of broadcasting, and anyone who had anything to do with it, or who owned an amateur transmitter was regarded by his fellows as something of a wizard. There was tremendous satisfaction to be gained from making things work—things that almost everyone today would regard as too simple or commonplace to give a second thought to.

How different is the picture today! The subject of radio has become a tremendous thing, as has its application, without mentioning non-radio uses of valves, such as now come under the general heading of electronics. Technical progress has been so great that it is no longer possible for one man to be expert in the subject as a whole, because the sum total of knowledge is so great as to make this an impossibility. The writer heard the other day of some of the jobs being done in England by men who would probably be grouped under the general heading of radio engineers. The extent to which they specialized was almost unbelievable, and it clearly pays their employers to subdivide their work in this manner.

But we are getting away from our original topic of radio as a hobby. The advances in technique that have made radio in all its forms one of the largest industrial undertakings in the world have had their repercussions in the amateur field. Transmitting and receiving practice, as it has advanced, has caused both types of equipment to become more and more complicated. It might be thought that this need not apply to amateur equipment, but this is a fallacy. The same conditions which have caused commercial gear to embody new technical ideas and practices, also apply to their amateur counterparts, so that in order to obtain satisfactory results, amateur equipment too must be brought up to date.

A good example of this is the amateur use of single-sideband transmission. Not so long ago, this was thought to be much too difficult a thing to be of use to amateurs, but today, its use is increasing every day. Now single-sideband technique is rather more difficult than ordinary radio-telephone practice, and it is not to be wondered at if many amateurs whose technical knowledge barely manages to keep them in business with ordinary communication methods have no desire to embark on what must seem to them to be solely for the experts. "Radio," they say, "is getting too technical." This is simply one example of how, as an essentially engineering subject progresses, it tends to get farther and farther from the ken of the average man. But there is no reason why those amateurs who feel this way about recent developments should despond, and think of giving up radio as a hobby.

Nor is there any justification for those who are better equipped with technical knowledge to criticize them for their attitude, saying that they *should* keep themselves up to date. As a hobby, there is no compulsion on anyone to learn more about it than he feels like. If a man wishes to know just so much about radio, or to do this and that, to the exclusion of something else, who shall say him nay? At the same time, it does seem that fewer radio hobbyists than formerly are interested in attempting to keep abreast of modern developments. This conclusion may be erroneous, but we do not think so. There is an increasing tendency among amateur transmitters in the United States to go on the air with ready-built equipment, and that is a thing which is definitely to be deplored. Most New Zealand amateurs still build their own transmitters and receivers, not to mention test equipment such as oscilloscopes, signal-generators, etc. And judging by the number of amateurs who turned up recently to hear a lecture on the aforesaid topic of single sideband, interest in new developments within the amateur sphere is far from dead. We think that this is a good omen for the future of amateur radio in this country, whatever else may happen elsewhere, and trust that such a healthy attitude may long continue. In time, we will probably find complete novices coming on the air with single sideband transmissions! We do not think that radio will lose its following as a hobby, even if some of us do not pursue it as far as others.

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A Design for a High-quality Audio System

After a critical examination of some popular audio amplifying systems, such as that due to Williamson, we have developed our own ideas of the performance and specification of equipment intended for construction by amateurs. These ideas have been embodied in a new design for a high-fidelity amplifier, together with the necessary pre-amplifying and tone compensation stages. This article discusses the whole question, and serves as an introduction to later articles describing the new equipment in detail.

INTRODUCTION

There is no doubt about it—progress is often a source of difficulty as well as a matter for rejoicing, and audio engineering is no exception. These days, when pick-ups speakers, and amplifiers have been developed to a pitch that was undreamed of not so many years ago, it would seem that no one has any excuse for putting up with poor reproduction from gramophone records; however, things are not quite so simple as that, because we now have more complications to resolve than we ever had before. For example, in order to achieve the excellent results of which modern design is capable, it is necessary to go to a great deal of trouble in the design of the amplifier. Williamson has undoubtedly shown the way in this respect. His amplifier was the first published design to have measured distortion levels of the order of 0.15 per cent., and the significance of his circuit cannot be over-estimated. Even so, Williamson himself would probably be the first to admit that it is not perfect, especially when it comes to the auxiliary circuits, distinct from the amplifier proper. It is even possible to level justifiable criticism at his main amplifier circuit, although everyone will agree that a properly built amplifier which meets his specifications is a very difficult thing to better, from the point of view of sheer performance. How is it, then, that this or any other journal has the temerity to recommend amplifier circuits other than the ubiquitous Williamson?

BETTERING WILLIAMSON

If this gentleman's name seems very much to the fore, not only in this article, but wherever audio amplifiers are mentioned, it is simply an indirect tribute to his work. This does not mean, though, that equally good results cannot be obtained by other means. For example, without wishing to blow our own trumpet too loudly, we might mention that one amplifier designed in our laboratory, and described in these pages ("The New High-quality Amplifier," *Radio and Electronics,* June, 1949) has often been commented upon as producing results indistinguishable by ear from those of a Williamson amplifier. Measurements on this amplifier showed its distortion to be very little greater than the latter's 0.15 per cent., at a maximum figure of 0.25 per cent., and yet our amplifier used less feedback than the Williamson, and a much less expensive output transformer.

It does not follow that either of these amplifiers represent the ultimate in performance. We do know, however, that from the point of view of harmonic distortion, these amplifiers are acceptable for the highest standards of quality. Even so, there are other factors besides this. If two amplifiers have the same measured performance, the one which uses fewer close-tolerance components will be the better amplifier, because it will be easier to build. From the manufacturer's point of view, this can result in a product of the same quality, but costing less to produce. From the angle of the amateur constructor, it may mean slightly lower cost of components, but it will certainly mean a much smaller chance of failure. By failure is meant the occurrence of oscillation when the prescribed degree of feedback is applied to the amplifier. This is the most to be feared fault on the part of anyone who builds feedback amplifiers, as it is often difficult to diagnose unless test instruments such

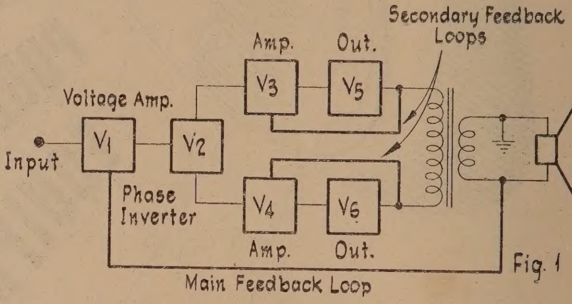
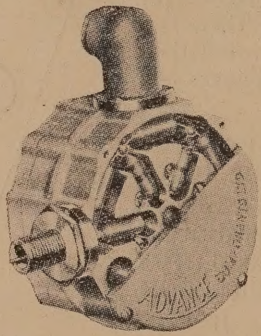


Fig. 1

"ADVANCE" A38

ATTENUATOR



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as a wide-range output meter (or V.T. voltmeter) or an oscilloscope are available.

Manufacturing concerns are usually very well equipped with test gear, and are also in a position to use close-tolerance components, whereas with amateur builders, the reverse is the case. Consequently, a design for a high-fidelity audio amplifier may be entirely suitable for production in a factory, but quite unsuitable as a design to "let loose" on amateurs. For the latter purpose, the design must contain a minimum of parts whose values must be accurately specified—preferably none at all, except where it is possible to obtain resistors and condensers to tolerances of 5 or 10 per cent.

It is with these thoughts in mind that we have designed a completely new high-quality amplifier, and associated pre-amplifier and tone-control circuits. The most important part of the job is, of course, the main amplifier.

THE MAIN AMPLIFIER

The block diagram of Fig. 1 shows the main amplifier in broad outline. The push-pull stage is preceded by a push-pull voltage amplifier stage. In front of this is a phase inverter, and ahead of this again is a further voltage amplifier stage. The unusual feature of the arrangement is that there are two feedback loops. One of these is similar to that of most amplifiers, in that it goes from the secondary of the output transformer back to the input stage. This has been labelled "Main Feedback Loop" on the block diagram. The other loop is a balanced one, from the primary of the output transformer back to the cathodes of the push-pull voltage amplifier stage.

At first sight, putting in two feedback loops instead of one looks like inviting more trouble, far from avoiding it, but such is not the case. In designing an amplfier which is to achieve very low distortion by means of heavy negative feedback, the main problem is to reduce phase shifts as much as possible, so that by the time the feedback has turned round and become positive (as it must at some very high and very low frequency) the gain from the input, through the amplifier, and back via the main feedback loop, is less than unity. As long as this condition is satisfied, there will be no oscillation. Now it would seem that the two requirements mentioned here are to some extent conflicting, because if we design for very small phase shift, we get a wide frequency response, willy-nilly. However, it is possible to overcome this difficulty by inserting *at one point in the amplifier,* a circuit which gives high attenuation at frequencies higher than a pre-determined upper limit. This has the effect of keeping the gain down, at frequencies above the audio range, without introducing much phase shift, and the scheme is found to work very well. A similar trick can be done for the low-frequency end of the scale, so that very low-frequency oscillation, more commonly known as motor-boating, cannot happen either.

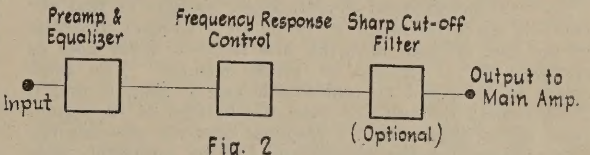

Fig. 2

The purpose of the additional balanced feedback loop is twofold. It reduces distortion in the last two stages, before we start to place feedback round the whole amplifier, and at the same time, it reduces the phase shift in this part of the amplifier. The secondary feedback loop also reduces the gain of the push-pull voltage amplifier stage, but this is simply the price we have to pay for its advantages. The degree of feedback applied by the secondary loop is not very great, so that there is no chance at all of difficulty arising solely on its acount. This is true because feedback is taken over only two stages, and it is well known that it is only when the feedback loop includes three stages, or three and the output transformer, that we begin to encounter stability troubles.

SUMMARY OF ADVANTAGES

Summarizing the advantages of the amplifier arrangement shown in Fig. 1, we have:—

(1) By using a push-pull driver stage, driver distortion as well as output stage distortion is cancelled out by the output transformer.

(2) By the use of a subsidiary feedback loop, it is possible to obtain a given low distortion level with less feedback in the main loop.

(3) Because of (2) above, the amplifier will be more inherently stable, since less feedback is used over the whole amplifier.

(4) Again because of the second feedback loop, it will be possible to apply more feedback in the main loop without causing instability.

(5) If the above advantages are capitalized to the full, it will be possible to construct an amplifier having even less distortion than the "Williamson", or alternatively, one with no more distortion than

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the "Williamson," yet with a greater margin of stability.

AUXILIARY CIRCUITS

While very few people will be found to level criticism at the main amplifier of Williamson, it seems to be generally agreed that his auxiliary circuits leave a good deal to be desired. It is not that the individual circuits do not work in the way they are supposed to, but rather on operational grounds that criticism of these circuits is justified. At the same time, the full Williamson pre-amplifier circuitry can legitimately be regarded as too complex, and suffering from the defect of using far too much amplification merely to throw it away again.

By far the greatest disadvantage, though, is that the controls give too much variation of frequency response to the user *without allowing him to know what kind of response he is getting at given settings.* The main result of this, and an undesirable one at that, is that it is extremely difficult for even the builder of the equipment to use the frequency response controls satisfactorily *while music is being played,* and for the completely non-technical user, who may have only a hazy idea of what the controls are supposed to do, intelligent use of these controls is virtually impossible. As a result we are often treated to the horrid spectacle of a full Williamson amplifier, complete with auxiliary circuits, which sounds unnatural to put it mildly, or even completely unlistenable, in spite of the fact that there is nothing technically wrong, and that there is a perfectly good record on the turntable.

PRACTICABLE TONE-CONTROL CIRCUITS

The above paragraph should not be taken to mean that the writer of this article disapproves of controls for giving a reasonable amount of variation in frequency response. It is his considered opinion, however, that stepped response controls are not only desirable, but essential if the user of the equipment is to know just what results to expect from time to time, and to reproduce exactly the conditions under which the same record is played on different occasions. Experience has shown that the ear is a very tolerant instrument, both as to changes in volume level and towards changes in frequency response. That is to say, quite substantial changes in response can be made before the ear is able to detect them, with the result that continuously variable response

(Continued on Page 48.)

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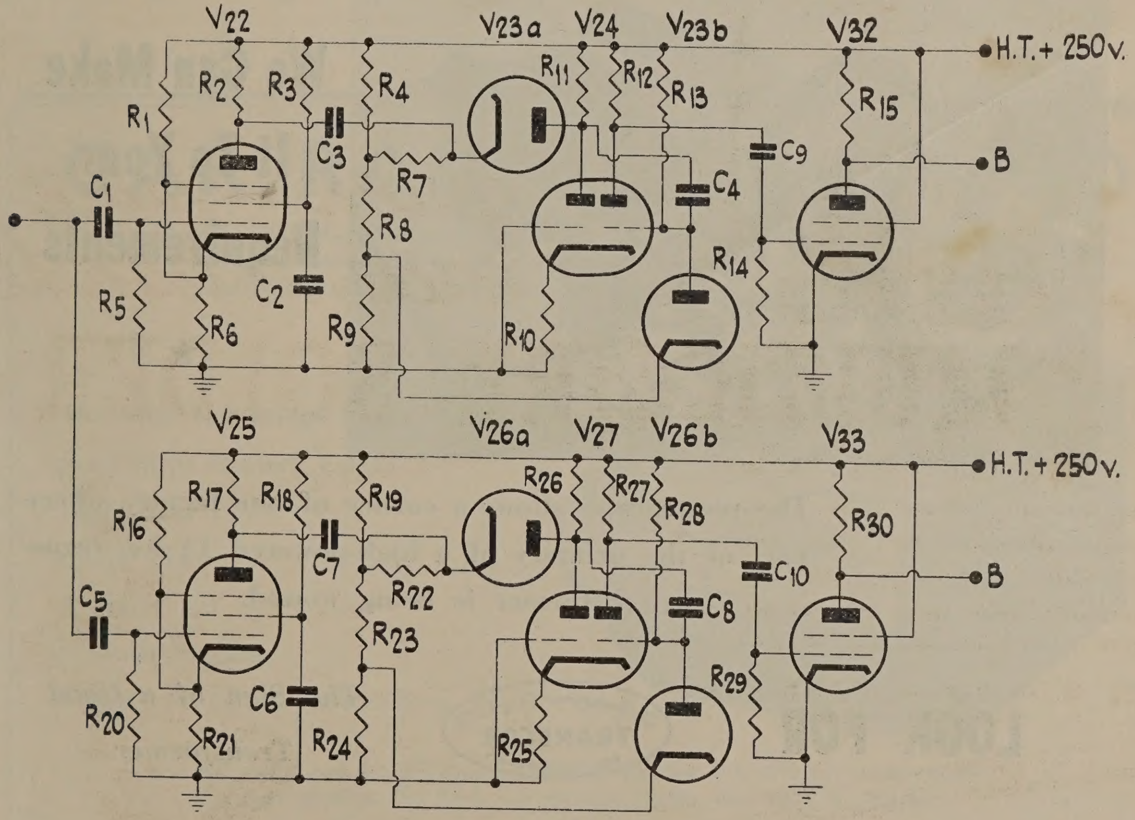
The "R. & E." Synch. Signal Generator—Part VI

This month's instalment of this series has had to be curtailed owing to the exigencies of space, and we apologize to readers who may be following the series. The circuits shown in Fig. 9 herewith are those of the two pulse generators for the frame blanking and frame keying signals respectively. The input signal is the output voltage of the last frequency divider, and comes from the point A on the circuit diagram, Fig. 7, which is to be found on page 31 of the June issue of this journal. The two circuits are identical except for the sizes of the timing condensers, C_4 and C_8, which are preset semi-variable condensers, of the type usually employed as padders in broadcast receivers. These are adjusted until the lengths of the pulses are 14½ lines long, in the case of the uper circuit, which is the blanking pulse generator, and 4½ lines long in the case of the lower circuit. The padders used were of about 400 $\mu\mu$f. maximum capacity, and a 100 $\mu\mu$f. condenser was connected in parallel with C_9 in order to make a pulse of 14 lines' duration possible.

The circuit values are identical with those of the frequency dividers, and are given in the table below. Included in the circuits are V_{32} and V_{33}, which are pentode buffers, whose purpose is to clip off the undesirable portions of the output waveform from the pulse generator, and to give a pulse with a perfectly rectangular shape. These buffers enable the pulses to be used in the succeeding circuits without complications due to overshoots, etc., which can be seen in the pulses as they come from the pulse generators. The pentodes are not operated at zero bias, as the circuit might seem to indicate. The grid circuits conduct on the positive pulses from the previous stage, and grid current builds up a large negative voltage across the grid leak resistors. This bias prevents the valves from conducting at all, except for the duration of the pulses, so that the average current in these tubes is very low. Across their plate load resistors appear negative-going pulses of about 150 volts amplitude, and it is possible to take the output to a number of different points without noticeable deterioration in the waveform.



COMPONENT LIST

R_1, R_{16}, R_5, R_{20}, 50k.
R_2, R_{17}, R_4, R_{19}, R_{15}, R_{30}, 10k.
R_3, R_{18}, R_7, R_{22}, R_{11}, R_{26}, 100k.
R_6, R_{21}, R_{12}, R_{27}, 5k.
R_8, R_{23}, 33k.
R_9, R_{24}, 2k,

R_{10}, R_{25}, 1k.
R_{13}, R_{28}, 3 megs.
R_{14}, R_{29}, 1 meg.
C_1, C_5, 500 $\mu\mu$f.
C_2, C_6, C_9, C_{10}, 0.05 μf.
C_3, C_7, 0.01 μf,

C_4, 500 $\mu\mu$f. fixed in parallel with 400 $\mu\mu$f. padder.
C_8, 400 $\mu\mu$f. padder.
V_{22}, V_{25}, V_{32}, V_{33}, EF91.
V_{24}, V_{27}, ECC91 or 6J6.
V_{23}, V_{26}, EB91 or 6AL5,

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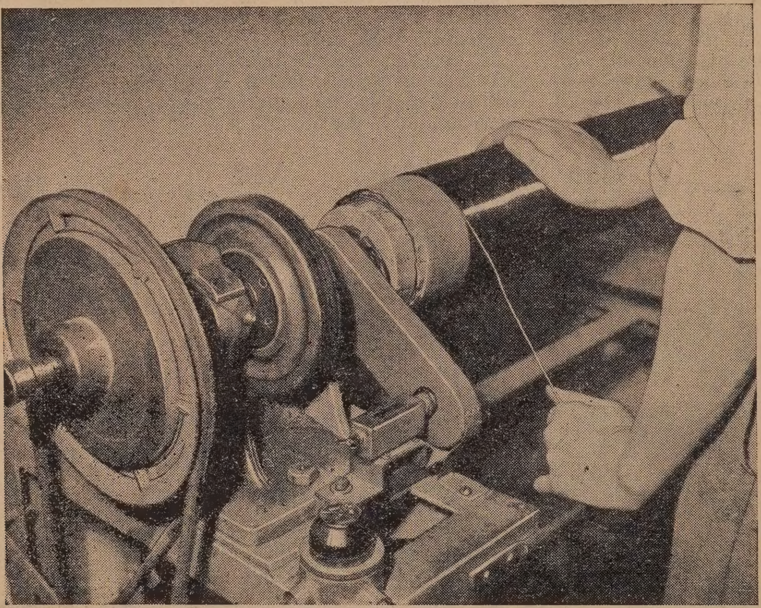

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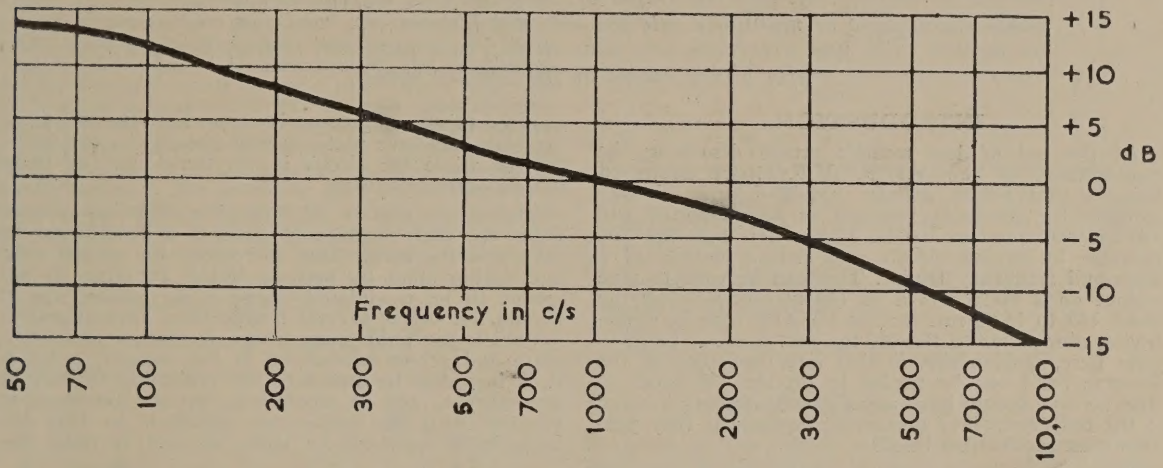
PLAYBACK CURVE FOR L/P RECORDS

We are indebted to Messrs. H.M.V. (N.Z.) Ltd. for the curve reproduced below. It is the playback curve recommended by the makers for all L/P records, 33⅓ or 45 R.P.M., bearing the H.M.V. or Columbia labels. Record enthusiasts will find it most useful to compare with the curves already published in *Radio and Electronics* and *Wireless World* for Decca L/P records.



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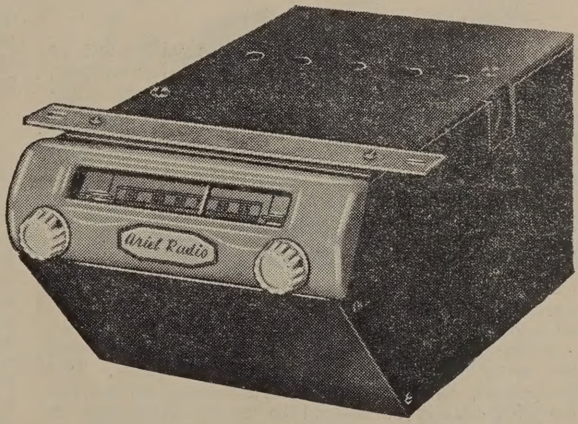

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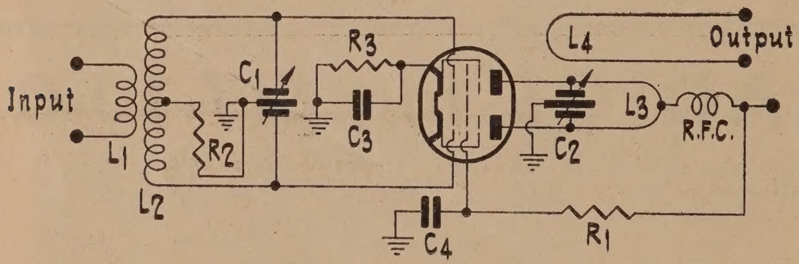
INTRODUCTION

At the end of last month's article describing the construction of the V.H.F., V.F.O., we promised readers that future articles would feature circuits suitable for producing signals on the 2-metre and 420 mc/sec. amateur bands. This article honours this promise by giving circuit and chassis details of a push-pull frequency tripler. This can be used to give output on 2 metres (144 to 148 mc/sec.) or on the band 140 to 153.3 mc/sec., as the first step in multiplying nine times to the 410 mc/sec. band. A point to note here, incidentally, is that any frequency in the 2-metre band can be tripled to hit the 420 band, so that no one should have any difficulty finding it, even if the only frequency measuring equipment they possess is on the 2-metre band!



L_1, L_2, see text.

L_3, L_4, C_2, commercial 2-metre tuning line with output hairpin and butterfly condenser.

C_1, 3–42 μμf. per section split stator.

C_3, C_4, 0.001 μf. mica.

R_1, 20k. 10 watts wire-wound.

R_2, 15k. 1 watt carbon.

R_3, 500 ohms, 5 watts.

THE CIRCUIT

Perhaps the first thing that readers will want to know is why we have used an 815. Unfortunately, these excellent transmitting tubes are no longer available, but we know that a good many were sold to amateurs from war disposal sources some time ago, and many of them are probably sitting on the shelf waiting for an application to come along. At the same time, there is a well-known Continental manufacturer who makes a direct equivalent, the type number being QQE04/40.

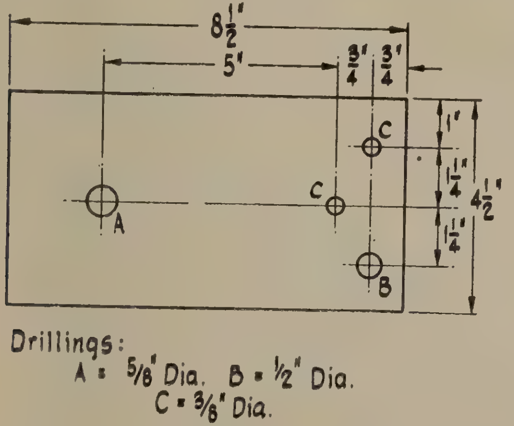
The output tank circuit is a transmission line, tuned by the valve capacities, together with a small butterfly variable condenser. The input circuit is a conventional coil and condenser combination. The grid coil, L_2, consists of 5½ turns of 20-gauge enamelled wire, wound with double spacing on a ¾ in. former. The coupling coil, L_1, is a single turn wound round the centre of L_2. It is connected to a coaxial socket on the side of the chassis, so that one end is earthed, and the other connects to the inner conductor of the coaxial cable. Since there is zero R.F. voltage at the centre of the coil, it is possible to do without an R.F. choke, and connect the grid leak, which is common to both sections of the valve, from the centre-tap of the coil to ground. Only a portion of the grid bias is obtained by grid current in the grid leak, the remainder being provided by the plate and screen currents flowing in the cathode resistor R_3. The purpose of this arrangement is to prevent the 815 from drawing excessive plate current should the excitation fail, or while the circuit is not tuned up, and there is temporarily no drive.

The screen grid is fed through a dropping resistor from the plate supply. If desired, a switch can be placed in the screen lead to remove the screen voltage during stand-by periods. While the stage is not meant to be modulated, there is no reason why it should not be, as several transmitters have appeared, in which the final stage was a frequency multiplier, plate and screen modulated in the ordinary way. If it is intended to modulate the multiplier, it will be necessary to add an electrolytic bypass condenser in parallel with the mica one specified, so that the cathode is bypassed for audio as well as radio frequencies. The same should not be done for the screen, however, because the screen must be modulated, along with the plate, and if the screen is bypassed for audio, only the plate will be modulated.

CONSTRUCTIONAL DETAILS

The working drawings for the chassis are given on the next page. To conserve bench space, the plate line is mounted on the front panel, so that the chassis is much deeper than it is wide. This also enables the grid tuning condenser, as well as the plate condenser, to be mounted on the front panel. The arrangement is not ideal, from several points of view, but has been found to work very satisfactorily. In the first place, it is not possible to obtain an entirely symmetrical arrangement of the grid circuit, as in order to do this, the condenser would have to be mounted parallel with a line joining the two grid pins of the 815. The coil former is mounted upright underneath the chassis, between the split-stator condenser and the 815 socket. However, this dissymmetry does not seem to have any effect on the performance of the stage. It was found that the drive to the two sections of the 815 was well balanced, and as that is the principal thing, provided adequate grid current is obtained, it was not considered worth while to alter the arrangement.

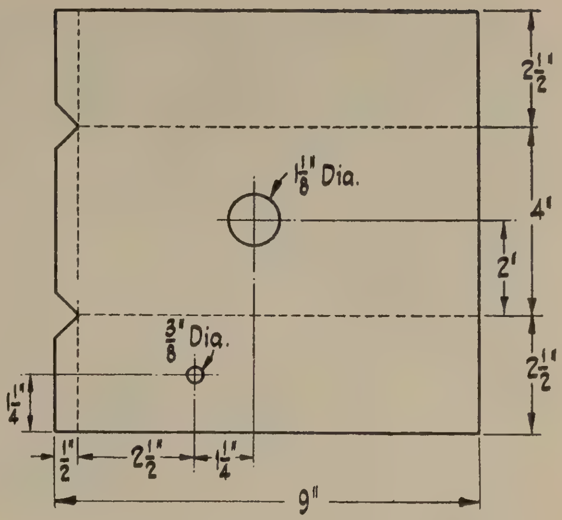
There is one point about the method of mounting the plate line that was found to be important. The rotor of the butterfly condenser was at first grounded to the chassis, by virtue of being mounted on the front panel. No difficulty was experienced until it was noticed that as the grid current was observed while the circuit was tuned through resonance, a small but definite "jump" in grid current occurred at one point. This was suspicious, and so the drive was turned off. As we suspected, there was still grid current present—the stage was oscillating. As luck would have it, the frequency turned out to be quite close to the intentional frequency of the stage, but moving the grid condenser had little or no effect on it. After investigation, it was obvious that the two sections of the 815 were acting as though they were a tuned-plate-tuned-grid circuit. Grid stoppers were found to effect a cure, but only at the expense of greatly reducing the available grid drive. Since this was in the region of six watts already, to use any more was decided to be a little unreasonable, and the cause of the parasitic was investigated further. It was soon found that by unscrewing the plate butterfly from the panel, and supporting it temporarily in mid-air, the trouble was entirely cured. We did not want to install a piece of insulating panel, spaced from the front panel, and thus totally insulate the butterfly from the latter. This would undoubtedly have cured the trouble, but would have meant making a new chassis! So the expedient was tried of enlarging the mounting hole, and insulating the shaft of the butterfly from the panel with a bush over the shaft. As soon as this was done, however, back came the parasitic. This did not occasion much surprise because the oscillation frequency being so high, it could obviously be supported by a small bit of capacitative coupling between the butterfly assembly and the chassis, just as well as by a direct connection. There must obviously be a critical value of capacity between the frame of the condenser and the panel, above which the oscillation took place, but below which it could not. The final cure was effected without making the new chassis, but by mounting the butterfly to the panel by means of small distance pieces, attached with bolts to the ceramic base plate of the condenser!



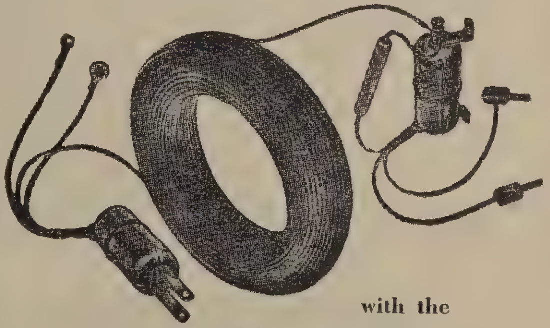
PERFORMANCE

Once the parasitic had been tracked down and abolished, it was possible to see what the performance was really like. The circuit values are quoted for an H.T. voltage of 400, but quite wide changes could be made in this figure without necessitating much alteration in the values. If much lower plate voltage is used, say 250 volts, it would certainly be necessary to alter the screen resistor in order to keep the screen voltage right. Our tests were taken with

(Continued on Page 48.)



Chassis and front panel (left).



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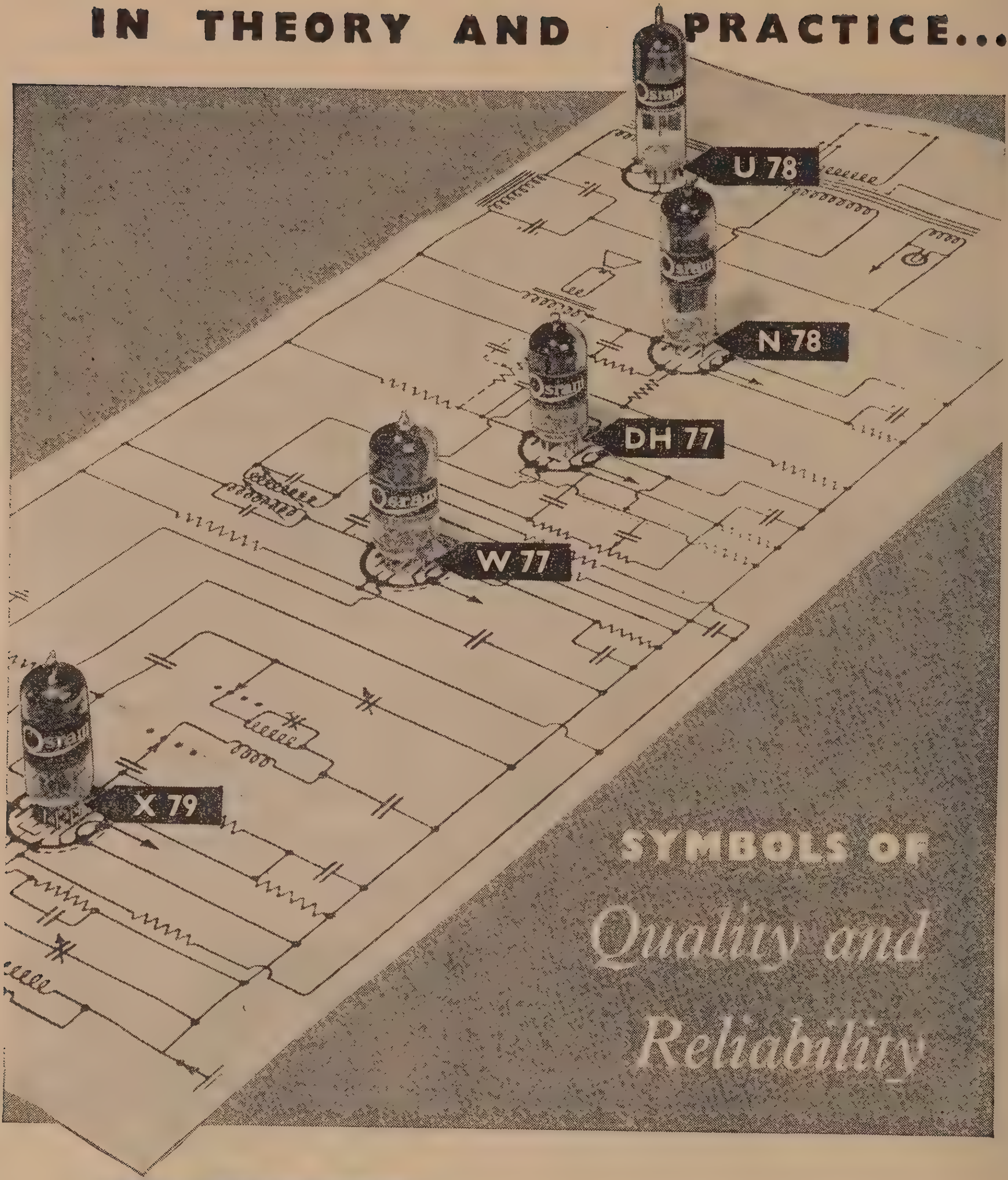

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QUALITY OF L.P. RECORDINGS

Sir,—In your editorial of April, 1953, you extolled the virtues of the E.M.I. group of L.P. recordings, both $33\frac{1}{3}$ and 45 R.P.M., and among other things, suggested that the discs would be of the quality expected from this type of recording, as any re-issues per this medium would probably be recorded from tape masters rather than from old disc masters.

Unfortunately, this does not apply to too many of the discs released. Recently, I purchased Act I of a ballet, recorded on 12 in. 78 R.P.M., four sides, and it is a most delightful recording, both technically and musically—a really brilliant effort. This week, I saw this same suite recorded on $33\frac{1}{3}$, and, as Act II was on the reverse side, I purchased this disc also. Imagine my disgust when it was discovered that the L.P. disc is a most dismal and dead affair. Both sets are from the same master, but the L.P. is hopeless. It should be mentioned that the reproducing equipment is really top quality, and by stepping back the top filter to 9 kc/sec. the 78 R.P.M. version simulates the reproduction from the L.P. So you can see we can expect very poor results from L.P. re-issues from this group of studios. Even the lack of surface noise does not compensate for a poor recording. After all, with good reproducing equipment, the surface noise on a good shellac pressing is relatively low. Possibly these discs are satisfactory for reproduction by the average record changer through the average radiogram, but why sacrifice the potential quality and make the discs useless for reproduction by high-quality equipment?

Could not the recording studios mark the labels to indicate that the disc is a dubbing with a severe top cut? It should be kept in mind that it is not possible, or rather not sensible, to play the discs before taking them from the shops, which unfortunately do not use good quality light-weight pick-ups for this purpose, and consequently the records are bought blindly with the hope that the manufacturer has done a good job. What an expensive disillusionment!

Similar results to the above have been obtained from the 45 R.P.M. discs. In all fairness, it is admitted that a disc under a different label from the same group, and obviously a genuine L.P. recording, is really very good, but I, for one, will be extremely careful when next I purchase L.P. discs.—Yours etc.,

E. S. A.

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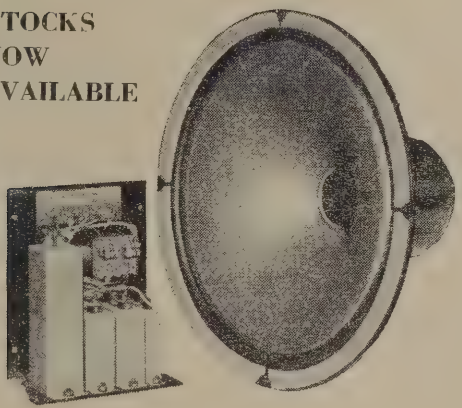

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Audiofacts No. 3

Intermodulation Distortion

The technical press, of recent years, has had a considerable amount to say about intermodulation distortion in audio amplifiers and other audio equipment such as pick-ups and speakers. The general impression to be gained from reading about it is that intermodulation distortion is something that has been discovered quite recently, and which arises through causes that have hitherto been unrecognized. Further, the stories say, the measurement of intermodulation distortion provides engineers with a reliable guide to the technical performance of audio equipment—much more reliable than the practice which has been standard for many years, of measuring harmonic distortion.

Some or all of this may be true, but the subject appears to the average man interested in audio work to be a very abstruse one which can not possibly have any direct interest for him. Special equipment is needed for measuring distortion by any means whatever, and that usually recommended for measuring intermodulation appears to be even more complicated and costly than the gear needed for measuring harmonic distortion. The user of audio amplifiers wants to know whether this "new" type of distortion really means anything to him in a practical way, and whether it is just another method used by design engineers for blinding with science those who just want their equipment to sound well, and who would prefer to build it themselves if possible. This article therefore attempts to explain what intermodulation is, why it is being hailed by engineers as something of importance in the audio world, and whether the amateur, or the professional who is not blessed with highly expensive test equipment, can measure it and make good use of such measurements.

WHAT IT IS

It is a long time now since engineers made a praiseworthy but not highly successful attempt to put the design of audio equipment on a sound scientific footing. They assumed (and they had to start somewhere) that the object of an electrical reproducing system was to take the original sound waves, convert them by some means into electric currents or voltages, amplify those currents or voltages without altering them in any other way, and finally apply them to a reproducer which would change them back once more into sound waves. The whole process was to be done in such a way that the original sound waves would be reproduced as faithfully as possible.

In making a rational attempt to achieve such an object as this, the first and most obvious question to ask was "What range of frequencies must the system handle if the utmost realism is to be preserved?" This one could be answered relatively easily, since it is not a very difficult matter to estimate and measure the frequencies delivered, say, by the instruments of the orchestra, or by the human voice. Very little thought indeed sufficed to show that the required frequency range was from about 16 c/sec. to 10,000 or 15,000 c/sec., and that the reproducing systems of the day were capable of handling only a very small slice of this band. Thus was born the idea that faithful reproduction required a wide range of frequencies, and it was natural that every effort should have been made to extend the response of microphones, records, pick-ups, amplifiers, and speakers. Nor was it at all illogical to inquire how much distortion could be tolerated in the equipment to be used. But before this could be answered, a good deal had to be done. How was distortion to be defined? And once defined, how could it be measured? Then, supposing these two questions had been settled, who was to say how much of the distortion, measured in the way decided, was to be counted as "tolerable"?

These were some of the chief difficulties facing early audio engineers, who were faced not merely with the problem of designing equipment which performed as well as possible, but with the difficulty that they had to make their own terms of reference before they started on the main job. Naturally enough, they then started to break the problem down into what seemed to them to be logical subdivisions. It was obviously impossible, they realized, to measure directly, how much a certain piece of equipment failed in its attempt to reproduce accurately the complex wave-motions in the atmosphere that we call sound. Even to measure the performance of the purely electrical part of a reproducing system was almost impossible, and certainly so unless certain simplifying assumptions could be made. For instance, the waves of current or voltage or current representing a given sound are so complex that no method could be devised for telling us whether an amplifier was distorting those waves. At least, the only way was to try and compare the reproduced sound with the original, and to find out in this way, in what respects they differed. The ear was the organ which ultimately had to decide whether a system was any good or not, but the ear is not an instrument which can be relied upon to make accurate measurements so that the question could be answered scientifically, and in a manner that would satisfy engineers that any new knowledge had been gained.

Because of this, the only way left was to start simplifying. The engineers decided to take the simplest possible form of electrical wave that can be converted into a sound wave, and pass this through the electrical system. Then, they argued, they would be able to see, with the aid of their instruments, whether the system was causing any distortion or not, and even perhaps measure it. The simplest form of signal was, of course, a sine-wave. This could easily be produced with reasonable accuracy, at any frequency inside the audio range. It was known, moreover, that when a sine-wave is distorted, the effect is to produce new sine-waves at frequencies of twice, three times, four times, etc., the original frequency. Equipment existed by means of which the amounts of these new signals present could be measured, both collectively and individually, so that the idea of using a synthetic audio signal appeared to be the final answer to at least one important question, namely how one form of distortion was to be measured. This form was called harmonic distortion, because the new frequencies which appear when distortion is taking place are harmonics of the original or fundamental frequency. The use of sine-waves as signals for measuring purposes also gave a very ready means of measuring the amount of another very important form of distortion which was labelled *frequency distortion.* This was the term invented to take into account the fact that practical audio systems did not respond equally to all audio frequencies. In the early days, frequencies below about 300 c/sec. and above 3,000 c/sec. were very difficult to reproduce, not only because of limitations due to the loudspeakers and microphones then in use, but also because audio amplifiers had been very imperfectly developed at the time. Thus was born the frequency response curve, which shows at a glance over what range of frequencies a piece of equipment has a "flat" response, i.e., equal response to all frequencies.

Having decided on these two criteria, namely frequency response and harmonic distortion, it appeared that by far the most important method needed for evaluating the performance of audio equipment had been evolved, and that all that was now needed was to improve everything in the chain to respond to wider and wider frequency ranges, and to give less and less distortion, as measured by the harmonic distortion test. Unfortunately, the effectiveness of this simple method of measuring audio performance was not as great as had been hoped, for a variety of reasons. In the first place, it was not possible to measure harmonic distortion if it occurred in proportions much smaller than five per cent. of the fundamental. Also, no one could rightly say how much distortion was tolerable. Tests were undertaken to try and find an answer to this one, and indicated that anything less than about five per cent. was difficult to observe by ear, and for a long time this figure was more or less standard. If an amplifier produces less than five per cent. harmonic distortion at a certain power output, it was good for use up to that output power.

For some time, engineers were quite happy about this state of affairs, and the question of harmonic distortion was considered as solved, because it is not a particularly difficult matter to make triode amplifiers, even of quite high power, to this specification. But the advent of the pentode rather altered things. It was found, for example, that five per cent. distortion on the part of triode output valves was much pleasanter to listen to than five per cent. made by pentodes. Engineers began to wonder whether the figure of five per cent. was perhaps not too high, and if so, what the maximum harmonic distortion should be. At the same time, of course, development had been taking place in microphones, speakers, and gramophone pick-ups, so that these components could now handle much wider frequency ranges than hitherto. This was partly responsible for the doubts cast on the old methods of evaluating amplifier performance, because as we now know, the wider the frequency response of a system, the more easily can the listener hear and recognize the different forms of distortion.

Further experiments were undertaken in an attempt to obtain a better correlation between the results of distortion measurements and the reactions of critical listeners, because it had been found that some very peculiar results were obtained by using distortion and frequency response measurements as the only way of telling whether an amplifier was good or poor. Attempts were made by commercial concerns to interest the listening public in what was conveniently labelled "high-fidelity" equipment, with the rather surprising result (at the time) that the public was not at all favourably impressed. Quite the reverse, in point of fact. It was found that the public at large did not like what the trade billed as "high-fidelity," and sets and amplifiers carrying this description were consequently not a commercial success. This gave the engineers furiously to think, and what came out of that thinking was this: that the measurement of harmonic distortion gave no sort of reliable clue to the pleasantness or otherwise of the audible results. Also, it was decided by the more advanced thinkers that from the point of view of giving pleasure to the ear of the listener, low distortion was of much greater importance than extended frequency range. Thus, the basic assumption that extending the frequency response of the reproducing system improves the realism or fidelity, as it is usually called, is incorrect unless it is qualified by the statement that increases in frequency range must be accompaneid by decreases in the quantity of distortion. Unfortunately, this applies not ony to the amplifier, but to all the links in the chain—speaker, gramophone record, microphone, and all. In some portions of the system it is a very difficult matter to measure distortion to this day, let alone reduce its quantity. However, progress is being made, and it is true enough to say that the average man today can afford audio gear which will give fidelity of reproduction which was only to be found in laboratories a few short years ago.

In particular, progress in the design of amplifiers has been excellent, and distortion levels that were unheard of a few years ago are now easily achieved. It has been found that very small amounts of distortion are recognizable by ear, and that the maximum acceptable figure is now in the region of 0.5 per cent. for the best possible results. But perhaps the most important discovery of recent years has been the fact that the measurement of intermodulation distortion is a much better criterion of amplifier performance than is harmonic distortion. We still have a great deal to learn about the whole subject, however, because even intermodulation measurements do not by themselves give an entirely accurate picture. Let us see what intermodulation is and how it is measured.

SOURCE OF INTERMODULATION DISTORTION

Like harmonic distortion, intermodulation arises in any device whose curve of input volts versus output volts is not a straight line. It cannot be observed or measured, however, if our test signal is a single pure or sine-wave. It only becomes a measurable factor if we put more than one frequency into the amplifier at a time, and it arises in a way that is familiar to everyone. In earlier days, the mixer stage of a superhet receiver was called the first detector, as indeed it was. In this stage, we apply two input frequencies to a valve whose input/output curve is not linear. This valve can be a diode, a triode, or a modern multi-electrode valve, but its kind does not matter. As long as its input/output curve is not a straight line over that portion of it which is used, the two frequencies produce intermodulation products. In the case of a radio frequency mixer, the main ones are the sum and difference frequencies. Usually we do not want the sum frequency, but only the difference frequency, and this we select by means of a circuit tuned to that frequency. Here, the idea is to produce intermodulation on purpose, but in an amplifier which is never a perfectly linear device, we get intermodulation products whether we like it or not. And since we cannot remove them, they appear in the output along with the two input frequencies, which we do want. For example, when we put 500 c/sec., and 6,000 c/sec. into an amplifier at the same time, we will get a number of output frequencies. First of all there will be the original frequencies themselves, and if the amplifier is a good one, these will be very much greater in amplitude than all the others. Then there are the harmonics of both the original frequencies, 1,000, 1,500, 2,000, etc., and 6,000, 12,000, 18,000 etc. These, of course, represent only harmonic distortion. Then there are the sum and difference frequencies, $6{,}000 - 500 = 5{,}500$ c/sec., and $6{,}000 + 500 = 6{,}500$ c/sec. These are the main, or first order intermodulation products, and if they are strong enough, they will be heard. Moreover, their effect on the listener can be expected to be worse than that of the harmonics, since they are not musically related to either of the fundamental tones. In other words, they will be dissonant, in the musical sense, and therefore unpleasing. In addition to these, there are other intermodulation tones produced between each fundamental, and the harmonics of the other, and intermodulation tones between the harmonics of both tones. For example, there will be present in small quantities such frequencies as 7,000, 11,000, 12,500, and many others, none of which are musically related to one of the tones. But for the fact that the two tones are in harmonic relationship to each other, there would be many more unwanted frequencies. It should be noted that all these tones can appear when only two frequencies form the signal for the amplifier, and that in music, many hundreds of frequencies are present in the signal, making the possibilities for the production of spurious tones almost limitless. It is small wonder, then, that when intermodulation distortion is bad enough to be audible, the effects are rather distressing. It is the multiplicity of intermodulation products which make amplifier distortion so unpleasant, especially when complex sounds such as those produced by a full orchestra are being reproduced. The separate intermodulation products cannot be recognized as such, but the sum total of them make up buzzing and rasping noises which completely spoil our enjoyment of what music is still audible. It is because of the much more pronounced audible effects of intermodulation distortion that its measurement affords a far better yardstick for the evaluation of amplifier performance than harmonic distortion measurements ever did. This is not to say that engineers and designers, or builders either, no longer have any use for single-frequency harmonic distortion tests or frequency response curves. These still have a useful part to play, but they must be taken in conjunction with intermodulation tests. Nor does it mean that the whole question of measuring amplifier performance is now "buttoned up." Far from it. There are several ways of measuring intermodulation, and those who know most about it agree that while any form of intermodulation testing is better than none, they still have not found a system of measurement which will enable instruments alone to tell us whether a certain amplifier will produce a better-sounding result than another one.

This discussion has taken up a good deal of space, and there is more of the story yet to tell. In particular, there is a way of measuring intermodulation distortion using only audio oscillators and an ordinary oscilloscope, that will certainly appeal to many of our readers. The method gives quantitative results, by means of simple measurements with a ruler on the correct 'scope pattern. It may not be as accurate as other methods, but it does enable useful results to be had with what is now

(Continued on Page 48.)

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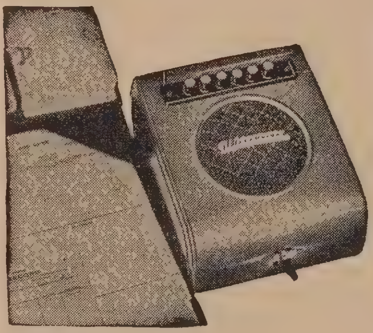

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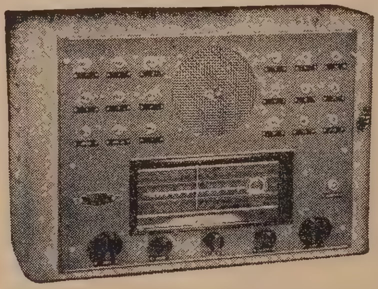

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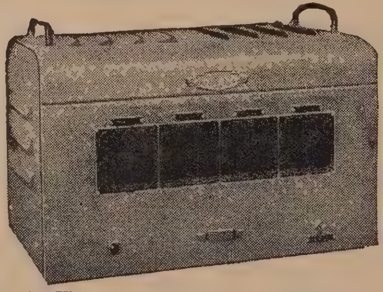

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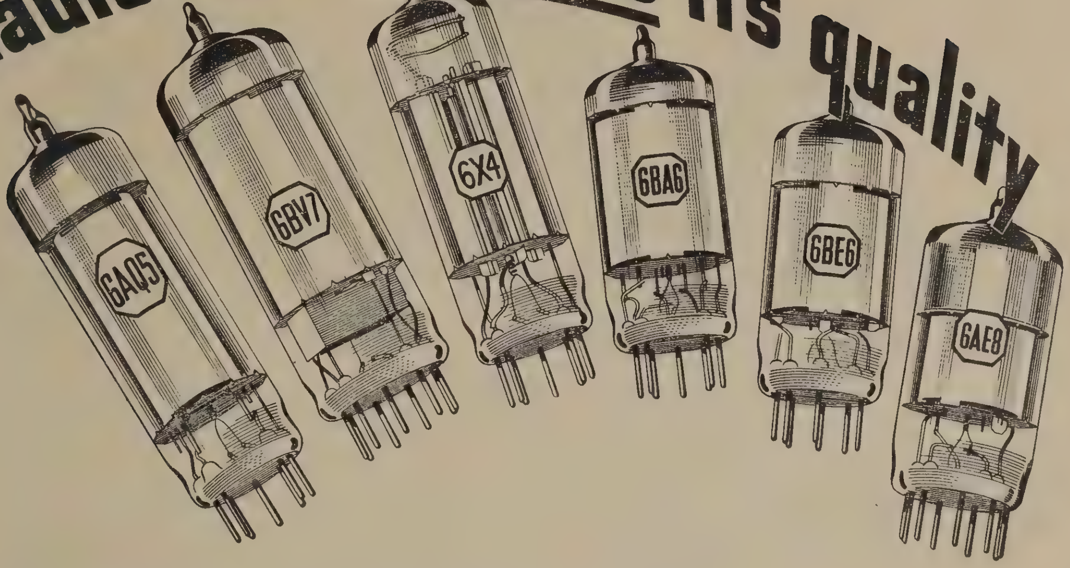

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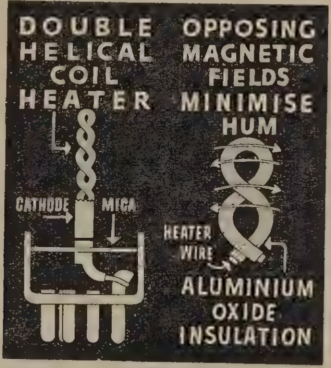
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The Transient Response of Audio Systems

By V. M. STAGPOOLE

Many of us have heard of transient distortion in audio amplifiers, but have very little idea of just what its importance is in the attainment of high-quality sound reproduction. In this short article Mr. Stagpoole indicates briefly some of the effects that can be expected in microphones and amplifiers whose transient response is poor, and points the way to possible explanations for puzzling imperfections of equipment hitherto regarded as being of high quality.—Ed.

In the past, and to a large extent at the present time, the audio engineer in measuring the performance of audio equipment makes use of a source of steady tone such as an audio oscillator, or constant frequency record to determine the characteristics of the device. It cannot be denied that a sine wave test is a useful and easily applied guide to the performance of an audio system. The word "guide" is used because it should not be assumed, as it often has been in the past, that the response of a system can be accurately gauged with tone.

The idea that a sine wave is the only suitable means of testing audio gear seems to be very difficult to eradicate if one judges by the faith placed in constant frequency records by many otherwise normal sound enthusiasts. The argument goes this way. "My amplifier is flat from 30 to 15,000 cycles by my constant frequency record. It has 20 db. of negative feedback and my speaker has a range up to 15,000 cycles—therefore I am getting perfect reproduction."

Only recently a reputable overseas radio journal published a letter from a correspondent pointing out that in a certain test, a sweep frequency record had been used and that consequently the result was not a sine wave. The original experimenter, in reply, pointed out that as the sweep rate was slow the signal was, to all intents and purposes, a sine wave.

To all of which the answer might be "so what?" There's precious little entertainment in listening to a sine wave. Music and speech consist of a constant jumble of a wide range of frequencies, many of an extremely transient nature. Audio engineers are only now beginning to realize that the transient response of an audio device is an extremely important parameter. It may come as somewhat of a surprise to the sound enthusiast to know that a sound system can be built which has a flat frequency response to 10,000 cycles and yet has a transient response down to 30 db's at that frequency.

The average listener seems to detect this straight away —he wants to turn to tone control to mellow so that the frequency response falls off at the same rate as the transient response, but the audio experimenter using constant tone for his tests is unlikely to notice that his results are less than natural.

The easiest way to visualize transient effects is to imagine a perfect loudspeaker which has a sine wave applied to it via a fast operating switch, then the output of the speaker should rise immediately to its full value. Let us put a microphone in front of this loudspeaker and examine its wave form on an oscilloscope. If the microphone has a perfect transient response its output should also rise immediately to its full value. If it takes some time to rise to reach maximum then the microphone has a poor transient response.

In practice it is found that most microphones suffer in this way to a greater or lesser degree. The controlling factor in microphone transient response is the resonant frequency of the moving member. Above resonance the transient response falls off at the rate of 6 db. per octave.

Ribbon microphones have their resonance well below audibility so their transient output is negligible. Dynamic microphones which have diaphragm resonances in the vicinity of 5,000 cycles or so give somewhat improved transients.

Only one microphone has been found entirely satisfactory as far as transient response is concerned and that is the miniature condenser microphone, which has recently come into great prominence. The principle of the condenser microphone is well known; it was in fact the first microphone that could be classified as "high fidelity," replacing the carbon microphone for broadcast and recording use. The old time condenser was a clumsy and erratic affair. It required a closely associated pre-amplifier and in those days there were no miniature tubes. Its large size rendered it very subject to moisture troubles and the large capacity of the head itself severely limited its bass response. With the advent of the original velocity microphones, the sound engineer heaved a sigh of relief and dumped his condensers in the basement for a well-earned retirement.

It soon became apparent that all was not well however, and that recordings made with velocity microphones were not as good, in general, as those made by certain companies, notably Telefunken in Germany, who continued to use the condsener microphone.

Well fate has turned the full circle and the condenser mike is once more coming into its own.

The new condenser is extremely small, its diaphragm being only about half an inch across with a consequent high resonance and superior transient response. It is reliable and rugged, and modern circuitry makes it likely that even the present small pre-amplifier will be eventually remote from the head.

It can be seen from this that unless the recording engineer is up to date in his choice of microphones he is beaten before he starts in the race for high fidelity.

Another cause of transient loss in recording is the cutter head. Quite a few moving-iron heads have very low resonances—around two or three kilocycles. Even when these are carefully damped with a lump of plastic, the transients disappear despite the flat response. Modern high resonance moving-iron heads do effect some improvement but it is likely that the moving-coil cutter will be the final answer in this field.

Have you ever seen this happen? The audio enthusiast who runs the gain way up and tries to fool himself that the raucous noise coming out of his speaker is high fidelity.

Transients peak some 15 db. above the average level, so that means that to avoid overloading your 15-watt "Williamson" you daren't run it above 1/2 watt average output. There is no way around this problem. If you want to deafen the neighbours with high quality sound

No. 7

LABORATORY NOTES
from
BEACON RADIO LIMITED

Beacon Transformers for the Williamson Amplifier

OUTPUT TRANSFORMER

A range of output transformers is carried in stock. Transformers in this range are made with three grades of core material. The low frequency response differs with each grade of material but the high frequency response remains unchanged.

The frequency response of the transformers having a nickel iron alloy core is rated at ± 1 db. from 20 c/sec. to 20 kc/sec. The next two grades of core material, namely supersilcor and silicon steel restrict the low frequency response by approximately 1 octave and 2 octaves respectively above 20 c/sec. At full output the frequency response of the transformers is virtually the same for all three grades.

The better grade transformers can be wired directly into the Williamson circuit. With the other two grades of transformer some reduction of feedback voltage may be necessary to avoid instability of the amplifier.

This range of transformers performs excellently in circuits employing push-pull pentode output stages working class A or class AB. Some modification of the overall frequency response is to be expected when pentodes are used in the place of triodes. A rising characteristic at 20 kc/sec. and above is found in the output voltage response curve. The low frequency response is not quite as good as when the same transformer is used with triodes.

Output transformers for special purposes such as the Acros ultra linear version of the Williamson amplifier can be wound to order.

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you'll need about 100 watts. The average listener need not despair however, 1/2 watt can sound pretty loud.

Incidentally, this means that the miniature capacity microphone gives 15 db. more output on peaks than a ribbon mike, and accounts for the apparent contradiction of many engineers saying that a ribbon mike sounds better. The transients from the condenser mike are simply overloading the associated audio amplifier and producing distortion. The ribbon microphone cannot follow the transients, produces no overload and therefore sounds better.

This 15 db. business puts the transmitter engineer in rather a fix. He cannot afford to run at about 10 per cent. average modulation, even given a source with good transients. However, experiment seems to show that if transients are present, even if somewhat lopped off, the results can be a substantial improvement upon the usual quality of transmission.

A scientist in the United States in a recent article showed that better results were obtained by keeping the transmitter transient response flat to about 5 kc/sec. rather than worrying about steady state response to 10 kc/sec.

Th advent of F.M. broadcasts or sound channels for television in this country, in the not-too-distant future we hope, should provide an opportunity for true high fidelity, as opposed to mere wide frequency range broadcasting.

I have said nothing so far about loudspeakers in regard to transient response, but it seems likely that the most satisfactory type will be that which uses a small aluminium, horn-loaded diaphragm for high frequencies.

In the past these have been sometimes criticized as "tinny" in sound. It now seems more likely that they were merely showing up transient overloads in the preceding amplifiers.

Finally, a word about amplifiers. It is often assumed that application of negative feedback is a cure-all for audio troubles. Certainly the use of feedback has enabled us to obtain distortion figures thought impossible a decade ago.

When feedback is applied to an audio amplifier over a large number of stages it takes an appreciable time for the signal to get from the input grid to the output transformer and back again, say to the cathode of the first valve. This means that during this period, before the negative feedback becomes effective, a signal as much as ten times greater than normal for an amplifier with 20 db. of feedback is being fed through the amplifier. As this is the period when the transients are present it means that severe overloading and distortion are quite likely to take place.

As well as the actual distortion introduced by the delay there is the possibility of excessive signals driving the grids positive and upsetting the bias arrangements. This delayed feedback effect will become more noticeable as the frequency range is extended upwards.

TRANSIENT TESTING

The most suitable method of testing for transients is due to Cook in the United States. His method of testing is to employ a source of wide-band noise, from a suitable noise generator, and apply it to the device under test. For testing audio equipment a noise bandwidth of 20 cycles to 20 kilocycles is used, and within this range all possible frequencies are present simultaneously.

In the testing of microphones the procedure is to place them in front of a loudspeaker, and set up all microphones to equal levels with steady tone. A source of noise is substituted for the audio oscillator and the difference in level between various microphones, if any, measured. It is found that the ribbon type of microphone gives some 15 db. less output on noise than the miniature capacitor microphone—a conclusive proof that the latter has a much better transient response.

By connecting an oscilloscope across the output of an amplifier fed from a noise source the overload point is easily detected. A case quoted by Mr. Cook was a 50-watt "high-fidelity" monitor amplifier which commenced to overload at an output of 0.8 watt!

The noise source can also be used to detect resonances in loudspeakers. Since all frequencies are present simultaneously any resonance soon builds up and its frequency can be measured by means of an oscilloscope.

In practice a noise generator is a complicated and expensive device so a noise record playable with a normal pickup is used. When these become generally available to the sound experimenter it will be possibile to construct equipment to more rigid standards than is at present possible.

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Model	Power Handling Capacity (Watts)	Frequency Range (C.P.S.)	Voice-Coil Impedance (Ohms at 400 C.P.S.)	Transformer Type
6H	4	90-6,500	3.7	D
6-9H	4	85-5,500	3.7	D
8H	4	80-6,000	3.7	D
8K	5½	80-6,000	2.0	C
8M	7	80-6,000	2.0	C
12M	7	75-5,500	2.0	C
12.0	7	65-6,500	2.0	C
12.0x	6	50-12,000	2.0	C
3C	½	225-8,500	3.7	—
5B	2½	130-6,500	3.7	G
5F	3	130-6,500	3.7	F
4-6H	3	130-6,500	3.7	G
6L	5	[illegible]	3.7	G

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"The time has come," the Walrus said,
"To talk of many things. . . . "

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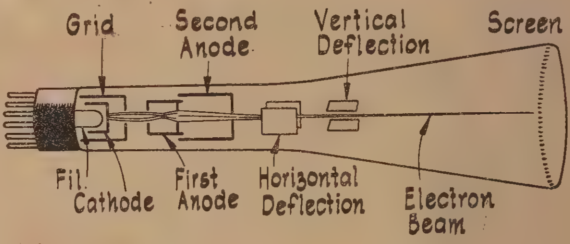
The Cathode Ray Tube

With television looming ever closer to New Zealand—who knows, somebody may actually make an announcement concerning it one day!—the cathode ray tube is going to become one of the commonplace features in the average home.

In the past, most service shops have been equipped with an oscilloscope to do a few odd jobs from time to time, but it's use has been strictly limited in so far as ordinary radio servicing is concerned and even then it is only useful in conjunction with other equipment such as an audio oscillator or wobbulator. Consequently, the operation of the tube and its construction is not widely appreciated, so a few words on the subject in simple language should not go amiss.

To begin the story, certain materials have the property of fluorescing or illuminating when bombarded with electrons, phosphor being one of these, and is considered suitable for television on account of its nearly-white light.

Other combinations of materials give green or blue fluorescence. Another factor which must be taken into account is how long the illumination is to stay after the electron bombardment has ceased. This is termed the persistence of the tube and is dependent entirely on the work the the tube will be doing—for radar applications with a slow repetition rate a long persistence tube is used so that the picture will stay put until the electron stream sweeps across the particular point again. In television tubes the persistence is quite short since the picture detail and electron stream change very rapidly. These particular coatings are then deposited on the end of the tube which is flattened and enlarged to form a screen for viewing purposes. It now remains to organize an electron stream to strike this screen, which is not too difficult to arrange. The conventional filament and cathode as used in most forms of valve is quite satisfactory for getting a first grip on the elusive electron. The filament and cathode are placed at the end of the tube farthest away from the viewing screen because quite a lot has to be done to the electrons before they reach the screen. The next element to introduce into the tube is the control grid, placed next to the cathode in order to effect some control on the quantity of electrons leaving the cathode. We now have electrons leaving the cathode, controlled in quantity by the grid but having nowhere to go so the next structure to be fitted in the tube is a plate in the form of a cylinder operated at a fairly high potential. Some electrons strike this plate and are absorbed by it, but the great majority pass through it being accelerated very considerably by virtue of the high positive voltage on it. This plate, termed the first anode, in conjunction with the control grid also focuses the electrons into a beam. Obviously just complete fluorescing of the face of the tube is not much use on its own—what we want is a sharply defined spot of light of very small proportions so that it can be used like a brush to paint a trace or picture—the smaller the spot the more sharply defined the image can be, hence the reason for focusing the electrons. The electrons are now travelling pretty fast, but not quite fast enough to preserve good definition so another cylindrical anode is added operating at a very high positive potential imparting a very high velocity to the beam which is now free to strike the screen and give a bright spot. The filament, cathode, grid, and anodes combine to form what is commonly termed the electron gun for obvious reasons.



The next requirement is to be able to shift the spot about the screen and this is done by placing two pairs of plates opposite to each other after the final anode of each electron gun. The pair of plates placed vertically either side of the electron beam is capable of deflecting the beam to right or left in a horizontal direction, depending on the voltage applied to them.

Here and now it should be stated that the beam is sensitive to electro-static charges and also to electromagnetic fields either of which can be used to move the beam about. In the case at present under discussion the electrostatic method is the one described. Now a pair of plates placed horizontally either side of the beam and fed by varying voltages can be used to move the beam in a vertical direction, hence by applying various voltages to these plates, termed the deflecting plates, it is possible to cover the entire screen of the tube with the beam. It should also be mentioned in passing that the electrons striking the fluorescing material liberate free electrons which interfere with the operation of the tube, so in order to avoid this trouble a graphite coating is applied to the inside of the tube and continued up to within perhaps one inch of the screen. This coating is connected to the final anode of the electron gun and thereby being at high positive potential absorbs the free electrons and conducts them out of the way.

In modern television receivers electromagnetic deflection is mostly used, and in place of the horizontal and vertical deflecting plates, external field coils are clamped over the tube in similar positions to the plates. Focusing is also achieved by means of another field coil placed around the neck of the tube. Varying the current through these coils varies the magnetic field from them which affects the electron beam in the same manner as the plates would do. The advantage of this method is that it reduces con-

(Continued on Page 48.)

The "RADIO and ELECTRONICS" Abstract Service

AERIALS AND TRANSMISSION LINES

A helical beam for the popular radio. The aerial has been made possible by advances in fibreglass mouldings. It is mounted on a ground plate and the helix is simply a coil of copper braid moulded integrally into a cylinder. The helical beam, with circular polarization, possesses advantages of strength, bandwidth, and pattern properties.

—*Electronics* (U.S.A.), March, 1953, p. 134.

Folded and loaded antennas—some suggestions for mobile and restricted-space radiators. Using a simplified method of calculating, the author develops values for the radiations resistance of various folded and loaded forms of short antennas. The article shows current and voltage distribution in the antennas providing a useful study for the beginner or the designer.

—*QST* (U.S.A.), April, 1953, p. 21.

AUDIO EQUIPMENT AND DESIGN

Further details of the R-J enclosure which has recently come into prominence, and which springs from the Helmholtz resonator, and which seems to overcome the difficulties of other forms. In this article some details of construction are given with formulae for construction adapted from radio concepts of impedance and "Q." It is stated to be readily possible to design a satisfactory cabinet for speakers smaller than 12 in.

—*Radio and Hobbies* (Aust.), May, 1953, p. 19.

A tone control designer must furnish the means for correction by the same circuit of all sorts of signal aberrations. The degree of tone-control complexity accepted in non-professional equipment has greatly increased. The article deals with treble boost and treble attenuation with graphs to illustrate frequency response under certain conditions.

Audio Engineering (U.S.A.), March, 1953, p. 22.

"De Natura et Jure Auditus ac Soni" is the title of a book dealing with audio in the year 1693, and some of its knowledge and the illustrations are astounding. We see the beginnings of our studies of acoustics, an "artificial ear" and various devices for trapping and propagating sound. He states: "If one takes a large jug which has been rinsed out with wine and drops a piece of lighted paper into it a fantastic and awful sound is said to result." But the author was no experimenter, or he might have seen here the nature of the Helmholtz resonator.

—*Ibid*, p. 25.

Theatre sound in small package: continuing the description of a speaker enclosure said to be of superior type. The design uses a tweeter and main horn, and full construction details are given, especially in regard to the metal horn covering. The construction is a fairly ambitious project, but the results are said to be well worth while.

—*Ibid*, p. 30.

Designing a tape recorder: the first of a series dealing with the problems arising out of the design and construction. The text is written more from the standpoint of a development engineer dealing with practical difficulties than from that of the research worker. Construction details are therefore given.

—*Wireless World* (Eng.), March, 1953, p. 108.

CIRCUITS AND CIRCUIT ELEMENTS

Much time has elapsed before a V.H.F.-U.H.F. tuner for a frequency span of some four octaves has evolved. The article is a survey of means of overcoming tuning problems in these regions; two slotted concentric tuners offer perhaps the simplest form of wide-range tuning mechanism, and other devices are described

—*Electronics* (U.S.A.), March, 1953, p. 106.

The design procedure and complete circuit is given for a new audio amplifier in which constant current operation permits the use of a form of automatic bias control to counteract tube ageing or replacement. With constant current operation there is little or no change in D.C. plate current as the signal goes from zero to maximum and therefore variations in power supply loading are negligible and the operating point remains constant.

—*Ibid*, p. 122.

ELECTRONIC DEVICES

The design of electronic calculators might seem an esoteric study in spite of its interest. The author deals with special codes and arithmetical processes which enable digital computers to perform rapidly many laborious tasks. The binary code is explained with simple examples of its working—its negative numbers and binary multiplication and conversion. This is an interesting and lucid introduction to the subject.

—*Ibid*, p. 150.

An article on telemetering and the basis of designs used for indicating data from a distance. The oldest and simplest form is the use of a variable resistance type transmitter connected to a D.C. supply and an ammeter indicator at the receiving end, and from there we move towards more reliable and involved devices for indication and control at a distance.

—*Electronic Engineering* (Eng.), April, 1953, p. 154.

INSTRUMENTS AND TEST GEAR

New equipment for impedance matching and measurement at very high frequencies: the slotted transmission line has long been used as a standard device for determining impedance but in the V.H.F. range it becomes a laboratory instrument. A test section of a low-loss coaxial line, which may be one-third of the slotted line may be used, fitted with fixed probes to measure the voltage amplitudes at fixed points.

—*Proceedings of the I.E.E.* (Eng.), Part III, March, 1953, p. 93.

A low resistance ohmmeter—the usual series ohmmeter is not very accurate for measuring resistance of less than about 10 ohms and many amateurs have doubtless wished for an instrument accurate on the low end. The instrument described has scale ranges of 237, 23.7, 2.37, and 0.237 ohms, using surplus meter. Full wiring and constructional details for this inexpensive instrument are given.

—*Radio and Television News* (U.S.A.), April, 1953, p. 61.

MATERIALS, VALVES, TRANSISTORS AND SUBSIDIARY TECHNIQUES

A further article on ferrite core inductors. Wave filters and networks depend on how high a Q can be obtained in the inductors, and there is considerable incentive to develop better Q factors. Permalloys and later molybdenum permalloys powered and insulated have become standard materials. The theoretical considerations are discussed, and also practical examples of variable inductors.

—*The Bell System Technical Journal* (U.S.A.), March, 1953, p. 265.

Transistors and their application: the first of a series of articles devised to give a clear understanding of transistors. The article is in popular style with a clear statement of the

(Continued on Page 35.)

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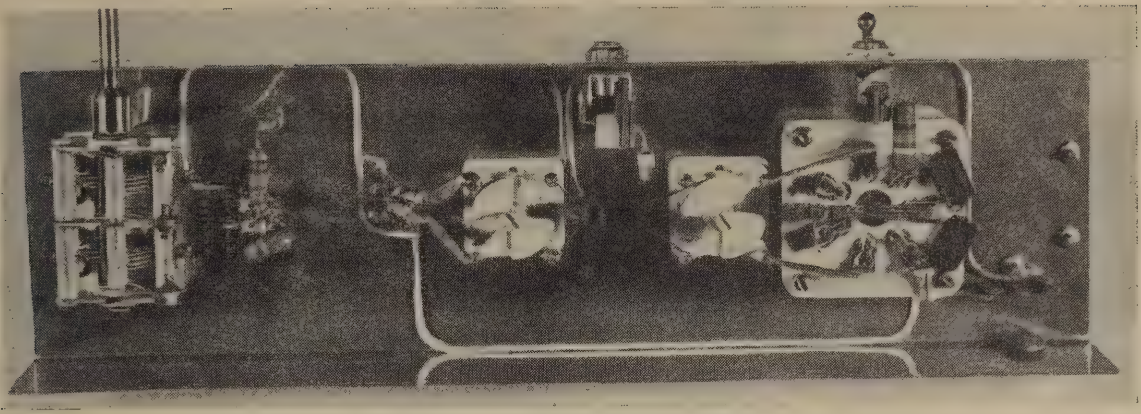
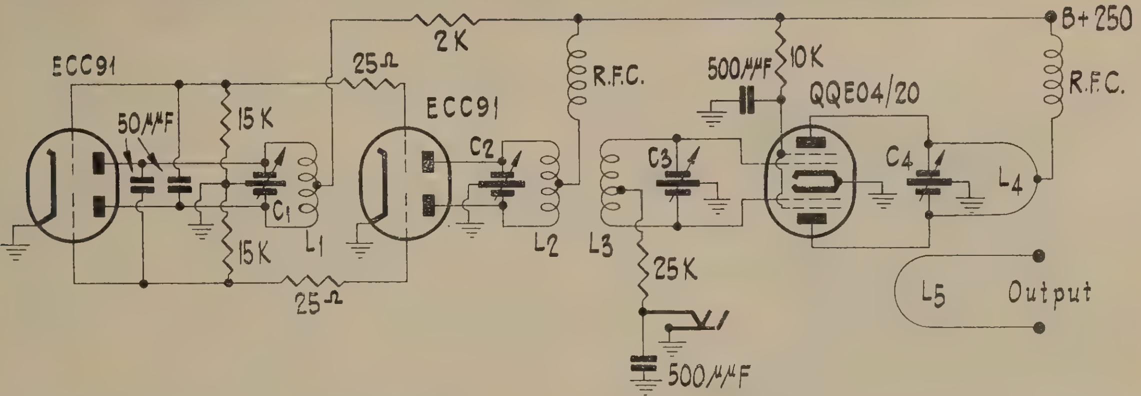
INTRODUCTION

There are two methods usually recommended to newcomers to the V.H.F. bands, for putting a signal on the air. The first is to use a very simple transmitter consisting only of a modulated oscillator, while the second is to ignore simplicity and go straight off for a crystal-controlled transmitter. The latter is undoubtedly the better scheme from the point of view of results, always provided that the transmitter is well designed and constructed, and can always be recommended to those whose constructional experience at lower frequencies is extensive, but for the man who has not been at the amateur game for very long, and who may have little idea of V.H.F. circuitry, as against ordinary high-frequency practice, a crystal-controlled transmitter tends to be rather ambitious.

At the same time, the self-excited modulated oscillator has very little to recommend it on technical grounds. It is certainly the easiest way of generating a relatively large number of watts at the high frequencies involved, but this one advantage is almost completely neutralized by the attendant disadvantages. Chief among these is the inherently poor frequency stability of power oscillators, and this shows up in a number of different ways. First of all, the frequency drifts as the valves warm up, and does not reach its final value until some considerable time after the transmitter is turned on; then again, changes in circuit conditions, such as are caused by altering the aerial loading, also have a considerable effect on the frequency. As a result of these two factors, it is almost impossible to specify the operating frequency with any worthwhile degree of accuracy, and it is not possible to work anywhere but in the middle of the bands if one is to be sure that the signal will not drift out of the band altogether. But the worst feature of all is the way in which frequency modulation is produced, as well as amplitude modulation, by all the recognized means of producing amplitude modulation. At first sight, this might not seem to be very serious, as long as the signal is well within the band, but in practice it is found to limit very seriously the effectiveness of the transmitter as a means of communicating intelligence from place to place. And after all, this latter is the object of a transmitter. The effect of the unwanted frequency modulation is to shift the carrier frequency about in accordance with the modulation, at the same time as its amplitude modulation is varied, and because of this, it is impossible to read the signal except on a receiver with very poor selectivity. About the only kind of receiver broad enough for the purpose, in the ordinary way, is a super-regenerative detector, which explains why this kind of receiver is always used with modulated oscillator transmitters on V.H.F. bands for which more advanced equipment is difficult or impossible to construct. With a receiver whose pass band is not broad enough to accept the whole signal—carrier and sidebands—however far the carrier frequency may wander, the modulation becomes quite unintelligible. In addition, of course, the signal occupies much more space in the band than a good signal should, so that the power is doubly wasted. With a modulated oscillator, the only way of limiting the amount of interference caused by the frequency modulation is to reduce the percentage modulation. While this is wasteful of carrier power, it does have the desirable effect of reducing the interference to other users of the band, and of enabling those with more selective receivers to read the signal.

If the ideal answer provided by a crystal oscillator/frequency multiplier type of transmitter is felt to be beyond the capabilities of the builder, there is a compromise solution which seems to be very little exploited, for some reason or other. It is to use a master-oscillator followed by a buffer or frequency multiplier stage, and finishing up with a power amplifier, working on the output frequency, and modulated in the ordinary way. The fact that there is a stage between the oscillator and the final amplifier reduces almost to negligible proportions any frequency modulation of the oscillator, especially when the buffer stage is also a frequency multiplier. Consequently, most of the advantages of the crystal oscillator are realized, while most of the difficulties associated with the construction of such a transmitter are avoided. The reason is, of course, that with the sort of transmitter we are describing, a much smaller degree of frequency multiplication is possible than is the case when a crystal oscillator is used. For example, when building a transmitter for the 2-metre band, whose frequency range is from 144 to 148 mc/sec., it is quite satisfactory to start off with the oscillator on the range 48 to 49.33 mc/sec. Then, the buffer can be made a frequency tripler, giving the desired output frequency. Were a oscillator to be used with commonly available crystals, the oscillator frequency would have to be in the region of 12 mc/sec. at the highest, and two more doubler stages would be needed.





THE CIRCUIT ILLUSTRATED

It is with these ideas in view that the design presented here has been produced. The final amplifier, which works "straight," is a Philips transmitting tube which readers of the "Experimenter" may not have come across before, namely, the QQE04/20. That is to say, it is a double tetrode, having a combined plate dissipation of 20 watts. Electrically, it is equivalent to the American type 832, just as the now well-known Philips QQE06/40 is electrically equivalent to the American 829. This is worth knowing, since only a few 832s have been available from war surplus sources in this country, in spite of the fact that a number of V.H.F. transmitters using them have been sold. We refer, of course, to the transmitter portion of the SCR522 aircraft equipment. Those who have these, minus the 832s, can get them into commission by making use of the QQE04/20, which is a plug-in equivalent. For modulated Class C operation, the maximum plate voltage is 400, with a screen voltage of 225, and under these conditions it is possible to get a good 20 to 25 watts output on the 2-metre band. With the high-gain aerials that can be erected at this frequency, such a power output is ample for almost all purposes, while for those who want to attempt the 420 mc/sec. band, it is more than enough to drive a QQE06/40 as a frequency tripler. With a modest 250 volts on the plates, and 180 on the screen, the prototype transmitter gave a good 12½ watts output.

Since the QQE04/20 is designed for push-pull operation with only one tube, the most logical way of feeding it is from another push-pull stage. The driving power needed is very small, so that it is possible to choose another double valve, the ECC91, as a driver stage. This valve is arranged as a push-pull frequency tripler, and with 250 volts on its plate drives the final stage very nicely. A push-pull tripler is rather more efficient than a single-ended one, and the ECC91 is ideally suited to this kind of circuit. It gives almost 2 watts output on 144 mc/sec. at a plate current of 25 ma. Although inductive coupling between the tripler and the final requires two tuned circuits—one at the plate of the multiplier and another in the grid circuit of the final, it was used after capacitative coupling had been tried and found wanting. It is well known that except in some circumstances, capacity coupling between transmitting valves is a most inefficient method of transferring power. However, when it can be used, it has the virtue of extreme simplicity. At very high frequencies, however, its disadvantages outweigh its advantages. It is not possible to use a suffiicently high ratio of inductance to capacity in the tuned circuit between the two valves, because with capacity coupling, the output capacity of multiplier and the input capacity of the final are directly parallel across the tuned circuit; this makes the latter of low Q and low L/C ratio, and prevents the multiplier from developing sufficient power output to supply both the circuit losses and the required driving power for the final. With inductive coupling, the losses are much smaller, in spite of the fact that there are now two tuned circuits instead of one. In particular, the multiplier,

(Continued on Page 27.)

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Philips Experimenter

(Continued from Page 25.)

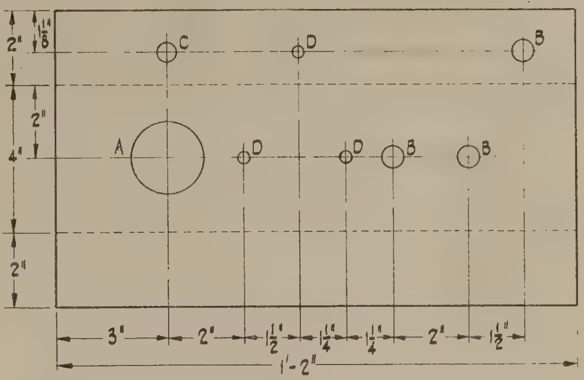
with its very small valve capacities, is able to have a much more efficient tank circuit. Similarly, the tuned grid circuit of the final can now have a more favourable L/C ratio, while the coupling to the multiplier can be very conveniently adjusted, simply by bending the coils towards or away from each other. A position is soon found in which maximum driving power, as shown by maximum grid current, it obtained, and since the operating band is quite narrow, the one adjustment holds over all of it without difficulty.

At very high frequencies, even more than at lower ones, it is important to preserve the balance of push-pull stages. While this can be done using conventional parts and layout, the use of the so-called butterfly condensers, in which the rotor-stator system is quite symmetrical, is of great assistance. In order to preserve the symmetry, the condensers were mounted on top of the chassis instead of on one side of it. Reference to the underneath photograph will show how this enables a perfectly symmetrical arrangement of the circuit to be realized.

As proof of the assertion that inductive coupling is best, it should be pointed out that the best grid current that could be developed in the final amplifier with capacity coupling was 1 ma., while as soon as inductive coupling was substituted, the drive went up to 1.8 ma. This represents ample leeway to take care of different tubes, because it was found that increasing the final grid current over 1 ma. had almost no effect on the power output, when 250 volts was used on the plates of the final. It is seen, therefore, that the additional 0.8 ma. will give enough driving power in hand to take care not only of valve variations, but of the case where it is desired to run the final at its full rated plate voltage of 400.

The oscillator also employs a push-pull circuit, and is direct-coupled to the tripler by the simple expedient of tying the latter's grids directly to those of the oscillator. The oscillator circuit is without doubt the best that can be devised for use with the ECC91, as it has excellent frequency stability for a self-excited oscillator, and is very efficient. It too draws only 25 ma. of plate current at 250 volts, and provides ample excitation for the tripler. As there is ample power output available from the oscillator, this simple form of coupling, although it may not be the most efficient that could be devised, is perfectly adequate, and saves components.

The output tank for the final amplifier is a tuned transmission line rather than an ordinary coil. It is an Eddystone tuning unit, comprising the transmission line, a butterfly tuning condenser, and a coupling hairpin from which the output power can be taken. These units are not expensive, and in addition to increasing the efficiency of the final, save a good deal of constructional work. It is supplied complete with its own mounting bracket, which is simply screwed to the chassis. Connection is made to the two plate pins of the final by means of two short lengths of braid, terminated in small clips. These are actually two lugs taken from an Amphenol octal valve socket. On no account should inflexible connectors be used, because these will expand with the heat conducted from the plate pins of the valve, and ultimately will put enough strain on the glass bulb to break it.



Drillings:
A = 2" Dia. B = 5/8" Dia. C = 1/2" Dia. D = 3/8" Dia.

CONSTRUCTION

The construction of the transmitter can be seen very well in the accompanying photographs. Apart from the fact that the layout follows the circuit diagram exactly, the main point to notice is that the socket of the QQE04/20 is set below the level of the chassis by mounting it on four distance-pieces. These are of such a length that the internal shield plate in the valve comes down exactly to the level of the chassis. In this way the chassis becomes a continuation of the internal shielding. Mounting in this way is essential if the best shielding between input and output circuits is to be realized; this is especially important when, as here, the tube is required to function as a straight amplifier, without neutralization.

The oscillator coil consists of 9 turns of 20-gauge enamelled wire, wound to a diameter of 5/8 in., and a length of 1 in.

The multiplier plate coil is wound with the same wire, and has 4 turns, of diameter 7/16 in., wound in a space 1/4 in. long.

The final grid coil is similar to the multiplier plate coil, except that it has only three turns, which are also spaced to occupy 1/4 in. of winding space.

A jack is provided for plugging in a meter for measuring the final grid current. No jack has been provided for measuring the final plate current, it being assumed that this measurement can be made by including a meter on the power supply chassis. However, there is no reason why a jack could not be placed on the chassis if desired. The standby switch, which can be seen on the right of the top-chassis photograph, cuts off the screen voltage supply to the final. If desired, this same switch can also cut the plate voltage, but this may be left on, since with the screen voltage reduced to zero, there will be no plate or screen current, even if plate voltage is still present. Note that a braid earthing strap is used to connect the cathode, the two ends of the heater and the rotor connecting lug of the grid circuit butterfly condenser, together by the most direct route possible. The small bypass condensers which can be seen on the socket of the final amplifier are connected directly to the cathode pin, and bypass the "hot" filament pin and the screen-grid pin respectively. In order to reduce the lead inductance, the connections from the stator lugs of the grid butterfly condenser to the

(Continued on Page 48.)

This Month's Television News

(Supplied by Dominion Radio and Electrical Corp. Ltd.)

Last year 782,000 television sets worth £44,000,000 were sold in Britain. A B.B.C. official recently told a "Producer Conference" that "sponsored TV has no money, no staff, and no future." Despite strong opposition it appears that England will have sponsored television within eighteen months and backers are confident of it being a sound and profitable investment. Forty-six applications have already been made for sponsored TV licences. Three dimensional films have been developed in an attempt to restore the cinema's falling box office returns. An increasing dollar earner is the export of half-hour television films from England to America. The films are produced at Elstree, the majority are compered by Douglas Fairbanks, and sales are booming. London's new Lime Grove television studios are already too small for current demand. Two millions receivers are now operating in England and a 78 per cent. coverage is claimed. New Zealand's Coronation contingent will have TV receivers installed in their huts. British manufacturers are concerned about the development of TV in Japan. Sets have been offered for early export by Japanese merchants at figures as low as £20. Britain's expanding export trade in TV receivers is being threatened. The B.B.C. is planning to experiment with educational television directed to 300 schools. British engineers are working on a superficially simple device which will simultaneously transmit both tele-communication waves and electrical power on the same wire. It is felt that the new device will have more ramifications than the invention of radar.

America and Canada

Philco's television production capacity has been increased by the opening of an additional 250,000 sq. ft. of plant in Philadelphia. Philco's 1953 production target is for more than 1,000,000 television receivers. Its overall merchandising turnover for this year will be in excess of half a billion dollars, and 2,600 people will be on the payroll. The month's most spectacular broadcast was a nation-wide television showing of an atomic bomb blast. This occurred over Yucca Flat, Nevada, and provided battle experience for thousands of combat troops. Television fever is sweeping Latin America. Brazil plans for a large number of additional stations. The little Dominican Republic has been transmitting since last August. Father Pritchard, head of the International Roman Catholic Organization, supports televising the Coronation. Father Pritchard says that one of the Queen's impromptu smiles would only enhance the dignity of the occasion, as humanity and dignity go well together.

Australia

Australia is much in the news at the moment as the Royal Commission on Television continues. Mr. Dunstan, a Melbourne newspaper executive, told the Commission that much of the criticism against television was

Reduce

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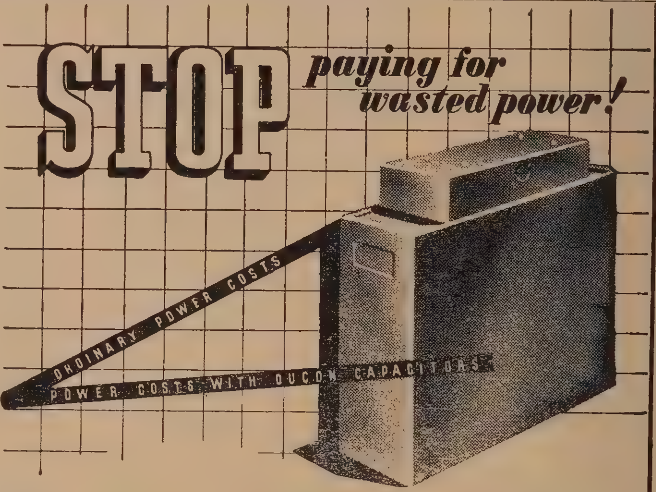

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"slanted." He went on to say that TV had boundless possibilities for good. The Rev. C. Bain gave evidence to the effect that the Presbyterian Church did not believe that uncontrolled TV censorship would regulate itself sufficiently and recommended a "panel of censors." Mr. N. V. Nixon, Federal President of the Association of Advertising Agencies believes the decency of Australian business men and sponsors would be sufficient control. He suggested, however, that programme standards could be set by a representative panel. Mr. R. F. J. Boyer, Chairman of the Australian Broadcasting Commission said in evidence that TV will open new fields of entertainment and culture. Mr. Boyer stated that no other medium held such hopes of securing the moral, intellectual, and spiritual welfare of children—and no other medium was more capable of degrading or lowering unseen childish impressions. He said that of the 19 countries now operating regular TV services all, with the exception of the U.S.A., have placed television under direct public control. He urged the public control of television in Australia. The Commission is still sitting and hopes to present its recommendations to the Government during the next session of Parliament. Popular Australian radio artist Jack Davey, in a recent visit to Auckland, stated that TV will be operating in Sydney within a year and major interested parties already have equipment and space available for transmission.

The importance of the electronic industry was effectively illustrated to the Australian House of Representatives in a recent address by Mr. A. Fairhall, M.P. Mr. Fairhall was speaking on the value of television development for defence purposes and stated:

"I regard television as a short cut to the deeper knowledge of the principles of electronics that underlie modern defence methods and believe that this young and isolated country cannot afford to be left behind in the defence field of electronic science."

We quote further extracts from the speaker's address as much is applicable to New Zealand.

"We should bear in mind the fact that, in time of war, television and electronics generally enjoy the highest priority.

"It is interesting to note that the modern fighter aircraft uses, in its electronic equipment, approximately 250 radio valves while the modern bomber may well employ 2000 or 2500 radio valves in its basic operating equipment. In a recent statement, the vice-chairman of the United States Defence Research Development Board pointed out that, whereas in 1937 a destroyer in the American Fleet used about 6 radio valves in its entire equipment, by 1944 that figure had risen to 840, and by 1952 no less than 3,200 valves were necessary to operate and control navigation, signalling and general defence equipment of those vessels," he declared.

"Already television principles are so closely allied to defence that we cannot have adequate defence without widespread use of them.

(Continued on Page 48.)

THE BASIS OF WORLD STANDARDS

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Technical excellence supported by constant research and an unrivalled knowledge and experience of Radio Frequency Cable applications, ensures the continuance of the lead established by TELCON in this field.

Some of the wide range held in stock by A.W.A., Wellington:—

TWIN TRANSMISSION LINES

70 ohm	150 ohm	300 ohm	
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		K.35	Tubular

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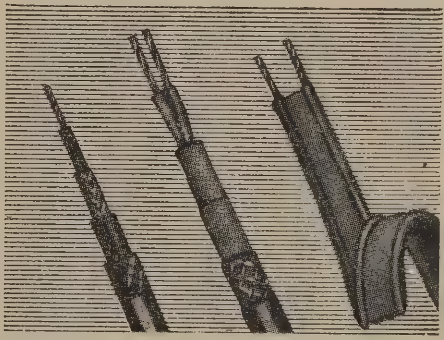
45 ohm	50 ohm	70 ohm	100/110
P.T.5.M.	K.16.M/	PT.1.M.	AS.48.M.
AS.93.M.	PT.9.M.	PT.11.M.	AS.91.M.
		PT.29.M.	

BALANCED TWIN (Screened)

BA.24.PSM. **BA.3.PSM.**
K.12.SM.



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Telcon Cables are manufactured by The Telegraph Construction and Maintenance Co. Ltd., London, and A.W.A. Telcon Pty. Ltd., Sydney.

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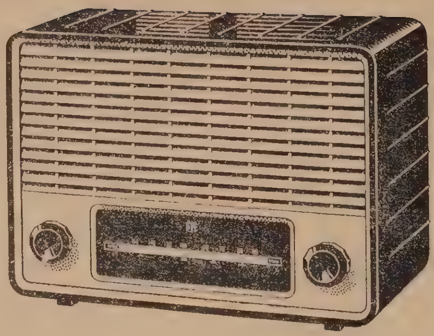

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Combining exceptional power with beautiful tone, Model "Y" offers perfect reception of a wide choice of programmes. Neat and compact and easily carried it can conveniently be used in any room you please. The cabinet is attractively moulded in contrasting colours.

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P18

TUBE DATA: The ECL80 Triode-Pentode

This valve, while designed primarily for multi-purpose applications in television receivers, has numerous uses in ordinary receiving sets, especially in the audio amplifying section. In TV sets, it can be used as a blocking oscillator and frame time-base output valve, or as an amplifier and separate clipping stage for the synchronizing signals, and for many other purposes. In radio receivers and audio amplifiers, however, it can find almost as many diverse uses. For example, in a high-quality receiver a pair of these tubes could be used as a push-pull output stage with an output of about four watts, with the triode sections used as push-pull drivers following a phase inverter circuit. Owing to its low power consumption, this arrangement would be excellent as the power output stage in automobile receivers. The high voltage sensitivity of the pentode section ensures that such a stage would require very little driving voltage.

Another use for the ECL80 would be as a combined audio amplifier and output stage in small receivers, where the use of a small loudspeaker makes the provision of more than 1½ watts of audio power superfluous. Designers will no doubt be able to find numerous other similar applications for this versatile valve. Full technical data are presented below.

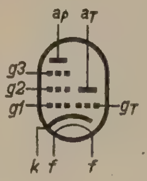
TRIODE AS A.F. VOLTAGE AMPLIFIER PENTODE FOR OUTPUT

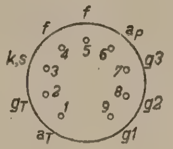
Extensive information referring to these uses are given under "Technical Data." The ECL80 permits the design of an audio amplifier of higher sensitivity than that of a normal single audio stage. Precautions should be taken, however, to avoid two possible sources of oscillation.

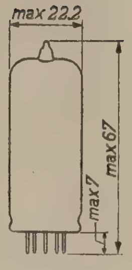
Oscillation at a low audio frequency may occur due to feedback through the common cathode resistor circuit when a common cathode resistor, tapped for the triode, is used. This may be avoided by using a long time constant in the cathode circuit ($C_k = 100\mu F$) and a short one for the coupling between the triode anode and the pentode grid ($C_{gt} = 5000$ pF; $R_{gt} = 0.68$ MΩ). The A.C. earth return of the circuit feeding the triode grid should be connected to the cathode, as otherwise the time constant of $C_{gt}R_{gt}$ may have to be further reduced.

Oscillation at a high audio frequency may occur due to coupling through the capacitance between the pentode anode and the triode grid. The impedance in the triode grid circuit should therefore be kept as low as possible ($R_{gt} = 0.2$ MΩ). The output transformer primary should also be shunted with a high-frequency RC damping circuit to prevent a rise in the anode load impedance of the pentode at the higher frequencies. In extreme cases it may be necessary to use a capacitor between triode anode and triode grid, or between triode grid and earth.

The tendency towards oscillation at a high frequency as mentioned above may, however, most conveniently be reduced by applying negative feedback from the anode of the pentode section to the triode anode. A resistor of 0.68 MΩ will suffice for this purpose. The effect of this form of feedback on distortion and sensitivity is such that the sensitivity is reduced to about half that obtained without negative feedback whilst the distortion is considerably reduced, especially at low output; for example, at 0.1 W without negative feedback $d_{tot} = 2.5$ per cent., and with negative feedback $d_{tot} = 0.5$ per cent.







61902

TECHNICAL DATA

Heater Data

Heating: Indirect by A.C. or D.C.; series or parallel supply.

Heater voltage	V_f	6.3 V
Heater current	I_f	0.3 A

Mounting position: Any.

CAPACITANCES

Pentode section	C_a	5.0 pF
	C_{g1}	4.5 pF
	C_{ag1}	<0.2 pF
	C_{g1f}	<0.25 pF
	C_{kf}	3.7 pF
Triode section	C_a	0.8 pF
	C_g	2.1 pF
	C_{ag}	0.9 pF
	C_{gf}	<0.05 pF
	C_{kf}	3.7 pF
Between sections	C_{gt-ap}	<0.12 pF
	C_{at-ap}	<1.2 pF
	C_{gt-g1p}	<0.2 pF
	C_{at-g1p}	<0.2 pF

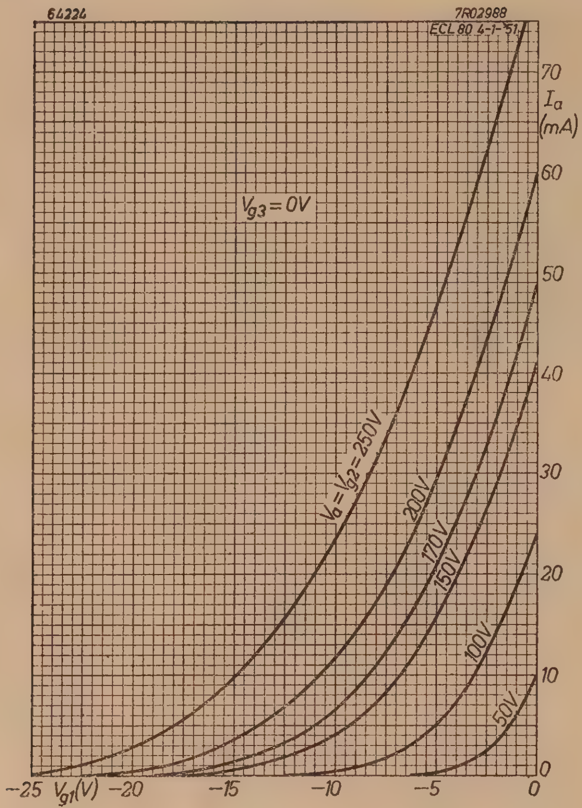
TYPICAL CHARACTERISTICS

Pentode Section

Supply voltage	V_b	170	200	250 V
Anode voltage	V_a	170	200	250 V
Suppressor-grid voltage	V_{g3}	0	0	0 V
Screen-grid voltage	V_{g2}	170	200	V
Screen-grid resistor	R_{g2}	—	—	4.7 kΩ
Control-grid voltage	V_{g1}	—6.7	—8	—12.2 V
Anode current	I_a	15	17.5	14 mA
Screen-grid current	I_{g2}	2.8	3.3	2.6 mA
Mutual conductance	S	3.2	3.3	2.6 mA/V
Internal resistance	R_i	0.15	0.15	0.2 MΩ
Amplification factor between screen-grid and control-grid	μ_{g2g1}	14	14	14

Triode section

Anode voltage	V_a	100 V
Grid voltage	V_g	0 V
Anode current	I_a	8 mA
Mutual conductance	S	1.9 mA/V
Amplification factor	μ	20



Grid Voltage v. Plate Current for the pentode section of the ECL80 for various plate and screen voltages.

LIMITING VALUES

Pentode section

Anode voltage at zero anode current	V_{ao}	max.	550 V
Anode voltage	V_a	max.	400 V
Positive peak anode voltage (10 per cent. of the duration of a cycle with a maximum of 2 m sec.)		max.	1200 V
Negative peak anode voltage		max.	500 V
Screen-grid voltage at zero screen-grid current	V_{g2o}	max.	550 V
Screen-grid voltage	V_{g2}	max.	250 V
Control-grid voltage (grid current + 0.3 μA)	V_{g1}	max.	—1.3 V
Heater voltage during the warming-up period		max.	9.5 V
Voltage between heater and			
Cathode current	V_{kf}	max.	150 V
Peak cathode current (10% of	I_k	max.	25 mA
the duration of a cycle with a maximum of 2 m sec.)	I_{kp}	max.	350 mA
Anode dissipation	W_a	max.	3.5 W
Screen-grid dissipation	W_{g2}	max.	1.2 W
External resistance between control-grid and cathode			
with fixed bias	R_{g1}		
with automatic bias		max.	1 MΩ
External resistance between		max.	2 MΩ
heater and cathode	R_{kf}	max.	20 kΩ

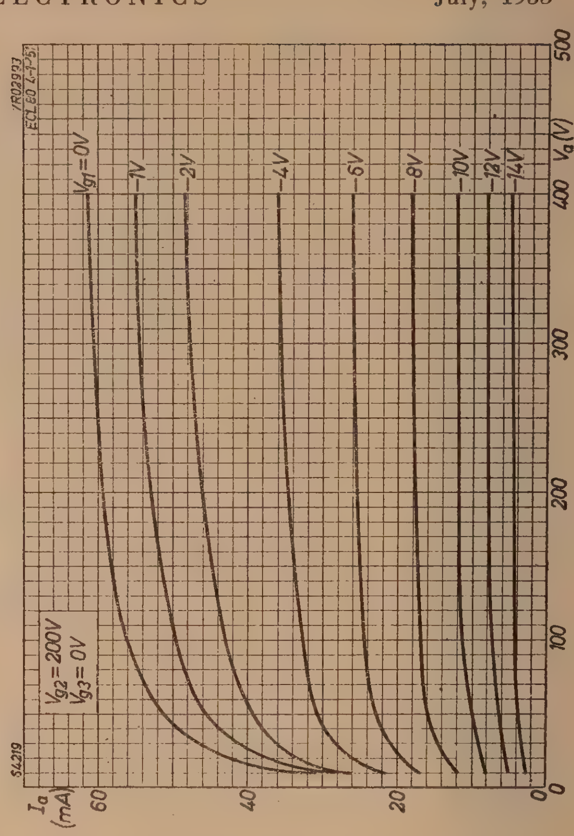
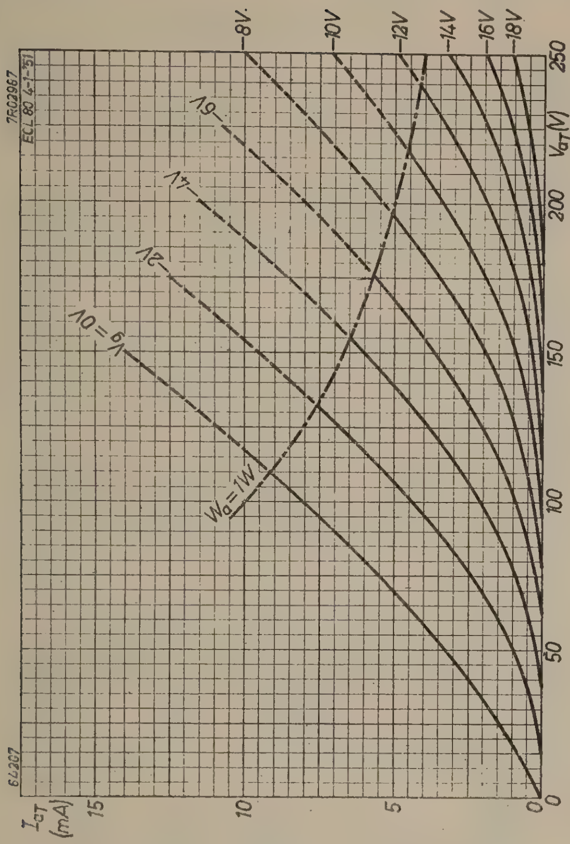


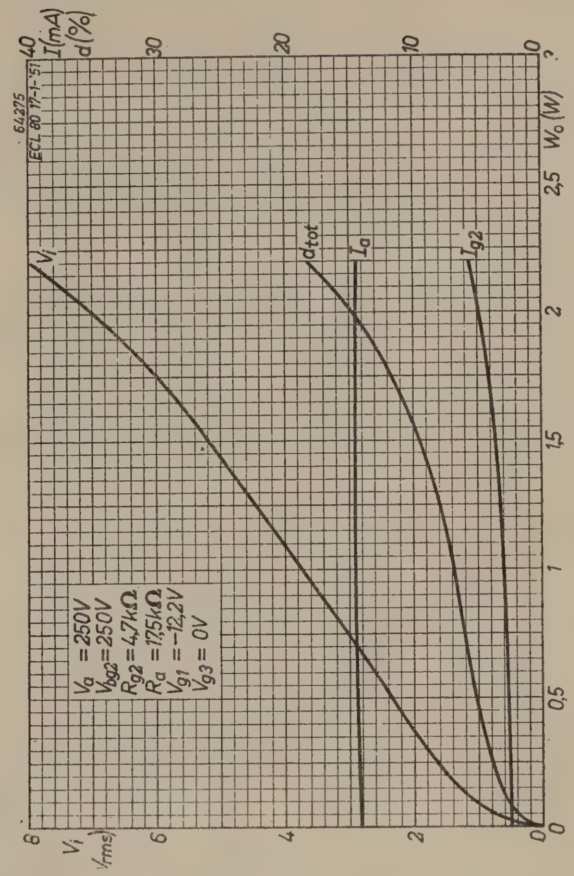
Plate characteristics of the pentode section for screen voltage of 200.

To allow the inevitable spread between individual tubes and for deterioration during life in frame output applications, the circuit should be designed around a peak anode current not exceeding 26 mA at $V_a=50$, $V_{g2}=170$ V. At $V_a=60$ V, $V_{g2}=200$ V the corresponding value for the peak current is 31 mA and at $V_a=70$ V, $V_{g2}=250$ V it is 42 mA.

Triode section

Anode voltage at zero anode current	V_{ao}	max.	550 V
Anode voltage	V_a	max.	200 V
Control-grid voltage (grid current + 0.3 μA)	V_g	max.	—1.3 V
Heater voltage during warming-up period		max.	9.5 V
Voltage between heater and cathode	V_{kf}	max.	150 V
Cathode current	I_k	max.	8 mA
Peak cathode current (10% of the duration of a cycle with a maximum of 2 m sec.)	I_{kp}	max.	200 mA
Anode dissipation	W_a	max.	1 W
External resistance between control-grid and cathode	R_g		
with fixed bias		max.	1 MΩ
with automatic bias		max.	3 MΩ
External resistance between heater and cathode	R_{kf}	max.	20 kΩ





Above—Plate characteristics of triode section. Right—Operating characteristics of pentode section under conditions shown in the inset table. Curves show R.M.S. input voltage, power output, total distortion, and plate and screen currents.

OPERATING CONDITIONS, OUTPUT TUBE

Pentode section

Supply voltage	V_b	170	200	250 V
Anode voltage	V_a	170	200	250 V
Suppressor-grid voltage	V_{g3}	0	0	0 V
Screen-grid voltage	V_{g2}	170	200	V
Screen-grid resistor	R_{g2}	—	—	4.7 kΩ
Control-grid voltage	V_{g1}	—6.7	—8	—12.2 V
Anode current	I_a	15	17.5	14 mA
Screen-grid current	I_{g2}	2.8	3.3	2.6 mA
Mutual conductance	S	3.2	3.3	2.6 mA/V
Internal resistance	R_i	0.15	0.15	0.2 MΩ
Matching resistance	R_a	11	11	17.5 kΩ
Power output (d_{tot} = 10%)		1	1.4	1,55 W
Input signal (d_{tot} = 10%)		3.7	4.1	5.3 V_{rms}
Power output (η = 50%)		1.27	1.75	1.75 W
Input signal (η = 50%)		4.4	5.1	5.9 V_{rms}
Input signal (W_o = 50 mW)		0.7	0.7	0.75 V_{rms}

OPERATING CONDITIONS AS A.F. VOLTAGE AMPLIFIER, **triode section**

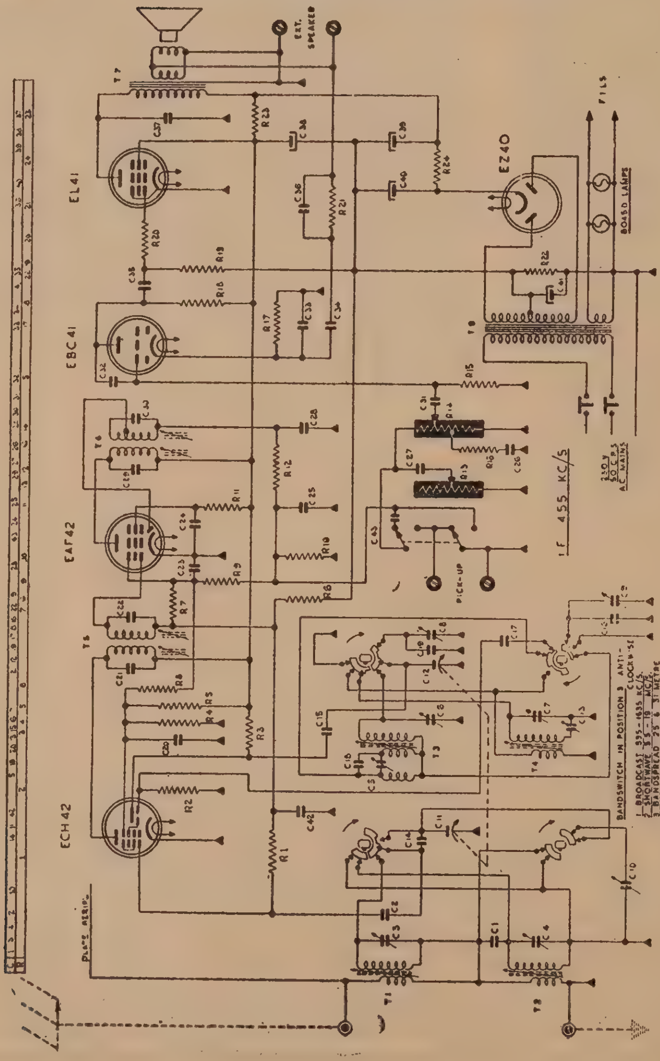
V_b (V)	R_a (kΩ)	R_g [1] (kΩ)	—V_g (V)	I_a (mA)	V_o [2] (V_{rms})	V_o/V_i	d_{tot} (%)
170	47	150	3.5	1.8	22	9.5	8.7
170	100	330	3.5	1.0	24	10.5	7.6
170	220	680	3.5	0.5	24.5	11	6.5
200	47	150	4.2	2.2	27	9.5	9.0
200	100	330	4.2	1.2	29	10.5	8.0
200	220	680	4.2	0.6	30	11	6.5
250	47	150	5.5	2.8	36	9.5	9.2
250	100	330	5.5	1.5	39	10.5	8.3
250	220	680	5.5	0.75	40	11	7.0

[1] Grid resistor of next tube.

[2] Output voltage at start of I_g. At lower output voltages the distortion is proportionately reduced.

HOME CONSTRUCTORS
FOR VALVES AND COMPONENTS
Write or call on
Cambridge Radio & Electrical Supplies
Box 6306 or 38 Cambridge Ter., Wellington

FOR THE SERVICEMAN—The Mullard Model 574



RESISTANCE AND CONDENSER VALUES

CONDENSERS

C1	3.9 mmfd ceramic
C2	150 ,, ,,
C3	3-30 mmfd air trimmer
C4	,, ,, ,, ,,
C5	,, ,, ,, ,,
C6	,, ,, ,, ,,
C7	,, ,, ,, ,,
C8	,, ,, ,, ,,
C9	175 mmfd w.w. trimmer
C10	,, ,, ,, ,,
C11	12-500 mmfd tuning condenser
C12	,, ,, ,, ,, ,,
C13	600 mmfd padder
C14	233 ,, ceramic ± 1%
C15	500 ,, mica
C16	120 ,, ceramic
C17	47 ,, ,,
C18	100 ,, ,,
C19	190 ,, mica
C20	0.01 mfd 400v. paper
C21	110 mmfd I.F. condenser
C22	,, ,, ,, ,,
C23	500 ,, mica
C24	0.01 mfd 400v. paper
C25	100 mmfd ceramic
C26	0.01 mfd 400v. paper
C27	1500 mmfd mica
C28	100 ,, ceramic
C29	110 ,, I.F. condenser
C30	,, ,, ,, ,,
C31	5000 mmfd 400v. paper
C32	10 mmfd ceramic
C33	0.05 mfd 350v. paper
C34	,, ,, ,, ,,
C35	0.01 ,, 400v. ,,
C36	500 mmfd mica
C37	5000 ,, 750v. paper
C38	20 mfd 350v. } Triple electrolytic
C39	40 ,, ,,
C40	,, ,, ,,
C41	100 ,, 10v. electrolytic
C42	0.05 mfd 350v. paper
C43	0.01 ,, 500v. ,,

RESISTORS

R1	1 meg. ¼w. carbon
R2	47k ¼w. carbon
R3	25k ¼w. ,,
R4	47k ¼w. ,,
R5	25k 1w. ,,
R6	2.2m. ¼w. ,,
R7	750k ¼w. ,,
R8	15m. ¼w. ,,
R9	1m. ¼w. ,,
R10	470k ¼w. ,,
R11	100k ¼w. ,,
R12	68k ¼w. ,,
R13	500k tone control
R14	2m. + 650k volume control
R15	750k ¼w. carbon
R16	50k ¼w. ,,
R17	2500 ohms ¼w. carbon
R18	150k ¼w. carbon
R19	500k ¼w. ,,
R20	1000 ohms ¼w. carbon
R21	75k ¼w. carbon
R22	125 ohms 1w. carbon
R23	1500 ohms 4w. w.w.
R24	500 ohms 4w. w.w.

Missing or Stolen Radios

Criminal Investigation Branch, Auckland

Skyscraper "City" A.C./D.C. broadcast, 4-valve radio, serial No. 10056; 6 in. speaker. Light brown wooden cabinet 24 in. x 18 in. x. 8 in.

Criminal Investigation Branch, Wanganui

Ultimate auto radio tuning unit, serial No. 149393; 12-volt; 2 tuning knobs; enamelled metal case 6 in. x 6 in. x 3 in.

Cromwell "Little Jewel" portable electric radio, serial No. 73727. Brown bakelite case 12 in. x 6 in. x 6 in. with carrying handle on top which fits back into case.

Police Station, Dunedin

"Courtenay" battery/electric portable, model 44, serial No. 91299. 12 in. square cabinet, oak colour, with handle on top; bars of speaker grille slightly disfigured through heat.

Criminal Investigation Branch, Christchurch

Pacemaker mantel 5 or 6 valve model, brown bakelite case, two knobs at front.

Criminal Investigation Branch, Wellington

H.M.V. 5-valve table model, serial No. 19844, cream plastic cabinet 9 in. x 6 in. x 6 in.; two dark coloured tuning knobs; 3 in. square dial.

RADIO RECOVERED

Ultimate, serial No. 129458.

* * *

"R. & E." TV Course

Bookings for this course, for which full details can be found in recent issues of this journal, are very heavy, and space in the lecture-room is limited.

Those wishing to attend are advised to register early, by remitting their fee of £4 4s. immediately, as it may not be possible to repeat the course in Wellington.

Abstract Service

(Continued from Page 23.)

difficult concept of "holes" and current amplification. The reader must be prepared, it is stated, to consider and master new concepts which may be radically different from many of the scientific principles he has studied earlier.

—*Electronics* (U.S.A.), March, 1953, p. 98.

Voltage stabilization: the first of a series of articles on this subject, the first dealing largely with glow-discharge tubes. Certain commercial types are given special mention and the effects of overloads, magnetic and electrical fields, vibration and storage have been noted.

—*Electronic Engineering* (Eng.), April, 1953, p. 160.

Noise in thermionic valves: when a radio engineer first meets the subject of noise he is apt to find it unsatisfactory. There is a formula developed by Schottky for the noise in a temperature limited valve and there are other formulae available but difficulties arise when he tries to apply these to active circuits. A new approach is given to the subject which has been found useful in teaching.

—*Proceedings of the I.E.E.* (Eng.), Part III, March, 1953, p. 91.

PROPAGATION

The reflection and absorption of radio waves in the ionosphere: an outline of the thory of ionospheric behaviour—the effects of double refraction, polarization, spatial attenuation, dispersion inhomogeneities and partial reflection which modify the apparent attenuation of radio waves reflected in space, are discussed.

—*Ibid*, p. 61.

The measurement of the phase velocity of ground-wave propagation at low frequencies over a land path: the paper describes the measurement of the change of phase over a particular path and the deduction of the mean velocity. It was noted that the influence of the nature of the soil was very marked with high velocity of ground of good conductivity and vice versa.

—*Ibid*, p. 73.

Although you might not suspect it the 14 mc/sec. band is never completely "dead." By taking advantage of a new type of radio propagation known as "meteor scatter" two stations can communicate far beyond the ground-wave range all night long. Briefly the explanation is the forward scattering from ionization trails left by tiny meteors which pepper the E region at all times. This is indeed a surprising fact and gives the amateur renewed interest and hope.

—*Ibid*, p. 11.

RECEIVERS

Design notes on a specialized phone receiver: it is pointed out that the best of commercially made receivers are a compromise attributable largely to wide coverage bandswitching and gang tuning. The amateur who builds his own receiver it is a unique position to by-pass all these problems by designing his receiver just to cover his favourite ham band. Instructions and circuitry are given for such a job, and its accomplishment would appear to be well worth while.

—*QST* (U.S.A.), April, 1953, p. 31.

TELEVISION

TV hints for the V.H.F. man: low-pass filters and transmitter techniques for use at 50 mc/sec. and upwards. The article deals with the sources of such interference some of which are receiver faults and nothing can be done at the transmitter to relieve them. A design of a filter is given for suppressing high-band harmonics, and also a low-pass filter for 50 and 144 mc/sec., with instructions for making these devices.

—*Ibid*, p. 16.

Receiver changes to improve fringe reception: this article covers tube changes for greater sensitivity and other circuit alterations.

—*Radio and Television News* (U.S.A.), April, 1953, p. 48.

D.C. restoration in television: passing the signal through an RC coupling removes its D.C. component and after the coupling the signal has no fixed level of reference and various means are used to supply it. A simple explanation is given of modern circuitry to meet requirements.

—*Wireless World* (Eng.), March, 1953, p. 102.

FERRANTI

RADIO AND TELEVISION EQUIPMENT

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Stroboscopic Lamps
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New Zealand Radio Traders' Federation

This year Christchurch was the venue of the New Zealand Radio Traders' Federation Annual Conference held in the Board Room of the Canterbury Chamber of Commerce on 19th and 20th May.

The Canterbury Association, as host to delegates representing Radio Traders from all over New Zealand, welcomed its guests in royal style. One of the highlights on the social side was the highly successful Tuesday night dinner, attended by over 40 guests, who took this opportunity to thank the Canterbury Association, and, in particular, the latter's President, Mr. L. Hepburn, for the warm hospitality and splendid organization of the Conference. This convivial function preceded a most interesting and instructive evening spent at Canterbury College, where Mr. B. Withers gave a practical demonstration of television. To cheer the weary delegates on their homeward way, the Conference concluded on Wednesday night with a picture evening at the Regent Theatre, followed by a gay supper party at the Mayfair lounge, which was thoroughly enjoyed by all.

Day sessions were crammed with much hard work. After apologies from Mr. R. Slade, of the Radio Manufacturers' Federation, and Mr. N. Laird representative of the Taranaki Radio Traders' Association, had been sustained, Mr. N. Souper, President, in opening the Conference, expressed his pleasure at the large attendance, and extended a warm welcome to Messrs. C. R. Peoples and J. Walsh of the Auckland Radio, Electrical, and Television Traders' Association, who had attended by special invitation.

The appointment of Mr. A. J. Howorth as proxy for Southland was approved.

APPOINTMENT OF NEW SECRETARY

With great regret Mr. Souper announced that, owing to the restricted budget it had been necessary to appoint a new Secretary, Mr. C. I. W. Archibald, public accountant of Wellington, whose appointment the meeting duly confirmed. Members expressed regret over the severing of the 25 years' link with the Employers' Association, but were reassured by Mr. Luxford, the retiring Secretary, that his Association recognized the inevitability of such a change, and gave its wholehearted approval. It was decided that the Radio Traders' Federation should purchase a suitable gift to be installed in the office of the New Zealand Employers' Association to mark the 25 years of service given by the latter to the Federation.

RADIO INTERFERENCE

To a question from Mr. Howorth concerning the interference received on station 4YC, the President announced that this matter had been taken up by Mr. Young and himself with the National Broadcasting Service, in an endeavour to have the frequency changed to improve reception of this station. In reply, the broadcasting authorities indicated that reception could be improved by an alteration to the intermediate frequency of receiving sets adversely affected. Few complaints had been received from listeners. Moreover, as this interference affected only residences close to the station, and, in view of the high cost of changing a station frequency, it was considered inadvisable to take any action at present.

However, the meeting resolved that the Otago Association should prepare a case for presentation by the New Zealand Radio Traders' Federation to the Minister, and that a copy of all the appropriate correspondence should be forwarded to the Interference Committee.

DRY BATTERIES

Dissatisfaction was expressed with the quality of New Zealand-made dry batteries and the lack of date code information. It was suggested that the Federation, either by itself, or through the Department of Scientific and Industrial Research, should investigate the life and quality of local batteries compared with imported ones. Mr. Peoples said that his Association was preparing a case for submission to the Minister, and suggested that the Federation should await a copy of this report. The meeting finally resolved that the matter of the quality of local dry batteries be taken up with the Minister of Industries and Commerce, and that the Federation should endeavour to obtain some satisfactory solution to the problem of quality and dating of batteries of New Zealand manufacture.

TELEVISION

A remit from the Wellington Association recommended that the executive should issue a statement to the public on the question of television and its effect on normal sound broadcasting. Mr. Souper emphasized that ordinary radio receivers would be always required as television receivers would not be suitable for normal broadcast reception. In spite of repeated unsuccessful efforts to obtain a Government policy statement, he still felt that only such an authoritative statement would make the general public realize that television does not supersede normal broadcasting. In the absence of such a statement, dealers in small towns are likely to experience a difficult time. "Television," said Mr. Souper, "is a luxury which, at the moment, New Zealand cannot afford, and on the basis of the present imports of radio materials, it would require at least £4,000,000 sterling to maintain television, apart from the initial outlay."

The suggestion that some of the uncertainty was due to thoughts of colour television was advanced by Mr. Foster of *Radio and Electronics,* though, in his opinion, this process was still largely in the experimental stage and was unlikely to be available in either England or America for at least ten years.

Finally, the conference resloved that, in view of past promises, a positive policy statement concerning television should be requested from the Minister. This would be appreciated by the public, and would be of assistance to the trade.

GUARANTEE PERIOD

Remits from the Wangani and Taranaki Associations requested a universal guarantee period of 90 days. It was stated that, owing to increasing costs, most of the cream from the sale of radio sets was absorbed by under-guarantee servicing, which, in many cases, extended for 12 months. Here, replacement of parts was a negligible item, the main cost being travelling time to collect unserviceable radios. While the manufacturer was prepared to replace parts free of charge, he made no contribution toward the cost of installation of same, or the collection of radios for servicing. Many delegates contended that the guarantee period should not extend for more than 90 days, and that there should be a clause requiring the owner to arrange delivery of the unserviceable radio to the dealer. It was revealed that, at

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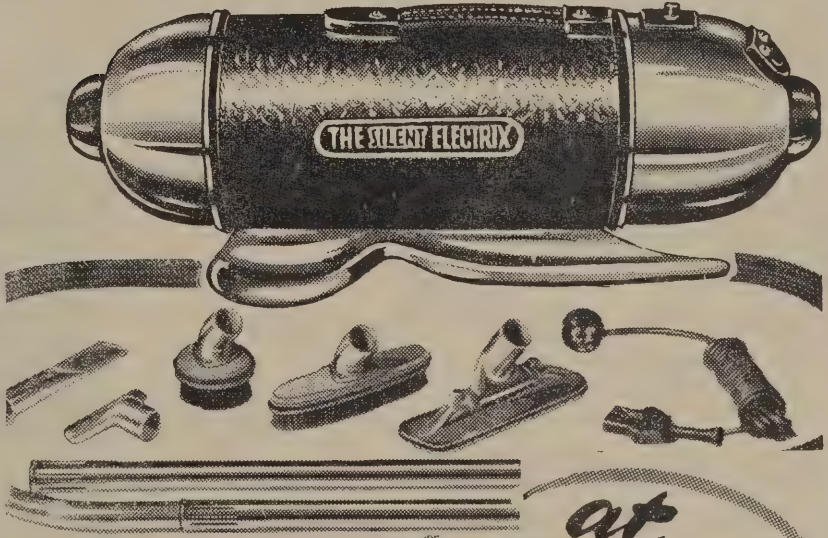

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present, there appears to be no consistency in the various centres concerning the guarantee period. In Auckland and Dunedin, many dealers give a 12 months' guarantee. Christchurch dealers maintain that they are able to sell their sets in competition with manufacturers offering a 12 months' guarantee, without any known loss of sales. According to Mr. Henderson, of Radio Corporation, Ltd., Auckland, who was specially invited to express the view of his firm, most radio defects appear within the first three months. His firm, while being prepared to service all sets for a period of 12 months, retains a clause in the guarantee requiring the purchaser to return the set, freight paid, to the branch from which the sale was made, though this clause is not always enforced. In view of the extensive advertising of this 12 months' guarantee, he felt that his company would not be prepared to agree to a lesser period. However, conference resolved that a universal guarantee be established for the radio trade for a period of 90 days.

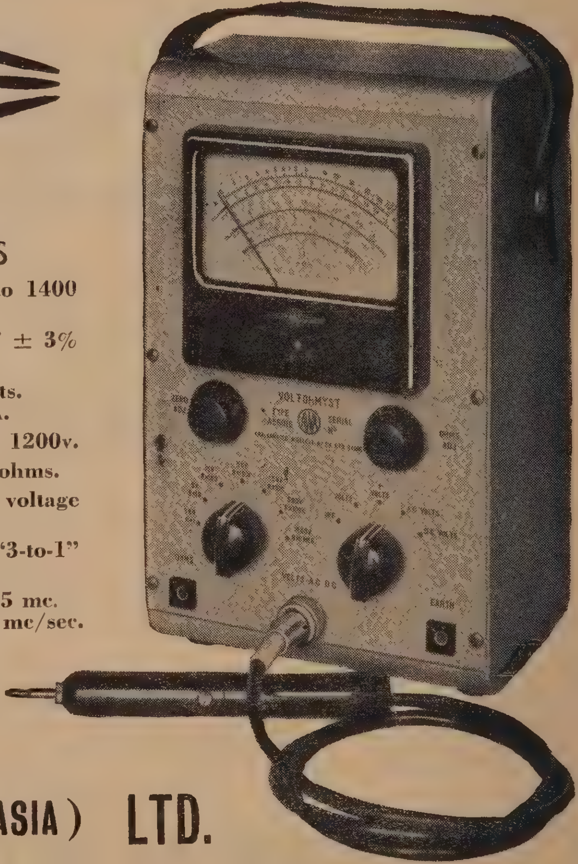
TRADE-IN HANDBOOK

The President indicated that this book was intended only as a guide to dealers, and the figures given therein should not be regarded as the only ones acceptable for a trade-in. Thanks of the conference were accorded to Mr. Souper for the production of this publication, and it was resolved that the next issue of the Radio Traders' Trade-in Handbook should be made in March, 1955.

RADIO INTERFERENCE

After hearing Mr. Billing's excellent report on the subject of fitting suppressors on electrical appliances, conference resolved that the report should be circulated to local associations.

It was suggested that the Government should introduce regulations prohibiting the sale, importation, and manufacture of electrical appliances causing interference. In the view of Mr. D. Billing, the public could materially assist itself in this respect. The Government pro-



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(8) Frequency response flat from 30 cps. to approx. 2.5 mc. Response with Xtal probe may be extended to 250 mc/sec.
(9) Negative feedback circuit provides over-all stability.
(10) Fully-enclosed metal case shields sensitive electronic bridge from R.F. fields.

AMALGAMATED WIRELESS (ASIA) LTD.

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AUCKLAND: VULCAN BUILDINGS, VULCAN LANE —— P.O. BOX 1363

posed to issue a special booklet with radio licences, while the Broadcasting Services would also assist by special broadcasting. Unfortunately, at present the scope of the regulations was so wide that courts were not prepared to enforce the latter. On the motion of Mr. Billing, it was resolved that the Federation bring to the notice of the Minister the fact that deficiencies in the Radio Interference Regulations of 1932 and amendments thereto prevented the implementation of the mandatory clauses, and urged that the legislation be redrafted so as to make these mandatory clauses enforceable in practice.

BROADCASTING HOURS

In reply to a request from the Federation for extended broadcasting hours now that the North Island power restrictions had been lifted, the Minister of Broadcasting had indicated that this was inadvisable until ample power was available in both the North and South Islands. After considerable criticism of this statement, conference resolved that the Federation should use its best endeavours to persuade the Government to restore full normal broadcasting hours.

CONDENSERS

As a background to the dispute between the Board of Trade and the Federation concerning the importation of condensers, delegates were informed that protection, on security grounds, was given to a local manufacturer for the production of condensers. However, as all the material used in the manufacture had to be imported, there seemed to be little advantage in the establishment of this industry and, moreover, the costs of condensers so produced were so high that the manufacturing costs of radios were materially increased. Despite this, the company concerned had been granted a virtual monopoly of all those types which it manufactured, while import licences for those types not manufactured locally were restricted to radio manufacturers. Consequently, radio dealers servicing sets containing imported condensers were unable to replace the latter, when required, and thus many New manufactured radio sets were rendered unserviceable.

At a recent discussion with the Board of Trade, manufacturers had contended that, had it not been for the local condenser manufacture, they would have been unable to carry on during the recent wharf strike. In this connection, however, the following points were brought to the attention of delegates:

(1) The shortage of condensers was occasioned by import restrictions and not the wharf strike.

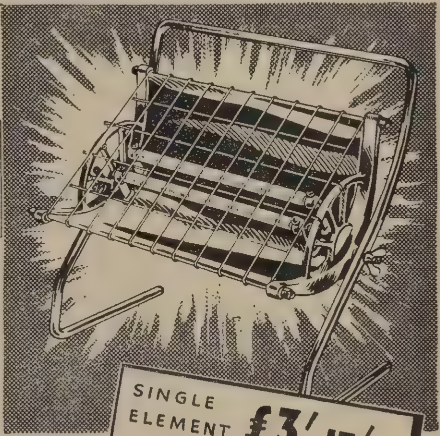
(2) As all materials are imported, the factory is of no strategic value.

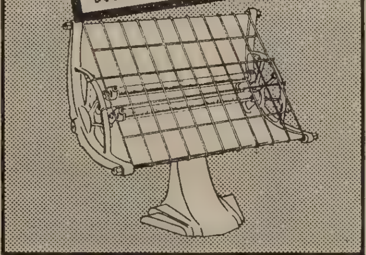
(3) The present restriction has created a monopoly.

It was resolved that the executive should press for the alleviation of the monopoly in condenser manufacture by the immediate issue of import licences to radio component importers to cover those types not manufactured in New Zealand.

RADIO LICENCE FEES

The Wellington Association considered that items of an educational and propaganda nature, such as the National Orchestra and short-wave services, were being wrongly charged to the Broadcasting Account, thereby causing a deficit, which might result in an increase in licence fees. Conference therefore resolved that, in assessing the costs of broadcasting in relation to licence fees, the Government be asked to exclude entirely all costs which are not relevant.





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ELECTRIC RADIATORS WITH THE SAFETY GUARD

N.Z. Agents: C. & A. ODLIN TIMBER & HARDWARE CO. LTD., WELLINGTON.

APPRENTICES

A remit from the Canterbury Association suggested that the production of a suitable leaflet detailing the advantages and working conditions in the radio trade might influence youths leaving school to seek apprenticeships in the radio industry. A highly successful pamphlet on these lines had been produced by Radio Corporation, Mr. Henderson of that company emphasizing the necessity for such a pamphlet to be distributed to schools and colleges early in the year, to compete fairly with other organizations seeking staff. It was also suggested that approaches should be made through organizations such as the Boy Scouts, and, on behalf of his district, Mr. Ferris offered the services of Boy Scouts in the distribution of pamphlets to boys of school leaving age. Finally, it was decided to leave the matter in the hands of the incoming executive.

TELEVISION EXHIBITION

Thanks were accorded to Professor McKelvie and Mr. Withers of the Engineering Department of the Canterbury University College for the time and trouble expended in providing the conference with an exhibition of television.

ACCREDITED RADIO DEALERS

From returns prepared by local associations, the incoming executive was instructed to compile a list of accredited radio dealers.

ELECTION OF OFFICERS

Before calling for nominations for the new federation officers and executive, Mr. N. Souper, the President, thanked all members for their co-operation during the past year, particularly mentioning the good work undertaken by Mr. L. Hepburn in revitalizing the Canterbury Association. Thanks were also given to the Press for their reports on the conference.

The election of officers resulted as follows:—

President: Mr. N. Souper.

Vice-President: Mr. L. Hepburn.

Executive: Mr. D. Chew, North Island Minor Associations; Mr. A. K. Griffiths, South Island Minor Associations.

Auditor: Mr. Gordon Berry.

Representative on Radio Interference Standing Committee: Mr. D. Billing.

VENUE AND DATE OF NEXT CONFERENCE

This was left to the discretion of the incoming executive, with a strong recommendation that the conference should be held in Napier.

OFFICIAL MAGAZINE

Radio and Electronics was re-appointed the official journal of the federation, and thanks and appreciation were expressed to Mr. W. D. Foster, Editor, for previous services.

MONTHLY BULLETIN

Thanks were accorded to Messrs. Young and Lord for their editorial work with regard to the bulletin, which was greatly appreciated by dealers.

SECOND-HAND DEALERS' LICENCES

The increase of this fee from 10s. to £2 2s. was felt to be scarcely warranted, as such dealing forms a very small part of an ordinary radio trader's business.

SALE OF WAR ASSET EQUIPMENT

Complaints had been received concerning the considerable quantity of surplus war asset materials imported into New Zealand at costs far below that for new materials. This was seriously affecting the sale of equipment in this country. Conference therefore resolved that the Government be requested to prevent the importation of goods from surplus war assets from other countries.

Conference closed with expressions of thanks to the Canterbury Association for the hospitality extended, and to the chairman, Mr. N. Souper.

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Inquiries are invited for the sale of this business. The trade-mark products are recognized throughout the country as being of the finest quality. The demand is great, and the potential selling there for further expansion. In the case of a straight-out sale, the present technical directive could be retained, as this has been a big point in establishing the product and its present quality.

Alternatively, an offer of additional capital would be considered, preferably from someone with experience and ability of the managerial side who would intend to take part in the operating of the company.

Initial inquiries, in the strictest confidence, should be by letter addressed to:

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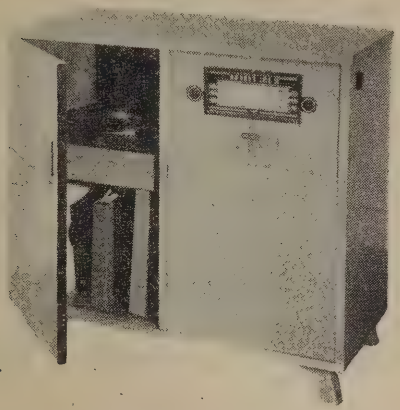
NEW PRODUCTS

"ULTIMATE" 6-VALVE WORLD-WAVE WITH 3-SPEED AUTOMATIC CHANGER



The new product illustrated in this column is a brand new radiogram model which should meet the requirements of those who want a radiogram with all the latest features at a highly competitive price. The 6-valve world-wave radiogram with 3-speed automatic changer has a capacious record cupboard and is built of solid oak timber, beautifully grained and tinted to either blonde or walnut shadings.

The "Ultimate" lowboy features a 10 in. Rola speaker and is priced at £79 19s. 6d. retail.

The lowboy is also available with a 6-valve world-wave chassis, 10 in. speaker and a 3-speed single record changer at only £74 7s. 6d.

This new "Ultimate" addition is probably the best value in lowboy radiograms on the New Zealand market today.

PUBLICATIONS RECEIVED SINCE 11th MAY

Wireless and Electrical Trader, Vol. 90, No. 1182, March 28, 1953.

A.T.E. Journal, Vol. 9, No. 1, January, 1953. Automatic Telephone and Electric Co., Ltd., London.

British Telecommunications Research, British Telecommunications Research Ltd., Taplow Court, Bucks, England.

Boletin No. 3, March 1953, Centro de Documentacion Cientifica y Tecnica, Mexico.

B.I.C.C. Bulletin No. 9, British Insulated Callenders Cables Ltd. (National Electrical and Engineering Co., Ltd., Wellington.)

The National Electrical Review, Vol. 2, No. 4, April, 1953. (National Electrical and Engineering Co., Ltd., Wellington.)

Machinery Lloyd, Vol. XXV, No. 6—14th March, 1953.

Electrical Communication, International Telephone and Telegraph Corporation, New York, U.S.A. (Standard Telephones and Cables Pty., Ltd.)

G.E.C. Journal, Vol. XX, No. 1, January, 1953. The General Electric Co., Ltd. (British General Electric Co., Ltd., Wellington.)

C.W.S. Stock Record, May, 1953. (Cory Wright and Salmon Ltd., Wellington.)

"Television Receiver Design" (I.F. Stages), by A. G. W. Uitjens, Philips Technical Library. N. V. Philips Gloeilampenfabrieken, Eindhoven.

Equivalent Radio Tubes Vade-Mecum, 10th edition, P. H. Brans, Antwerp, Belgium.

N.Z. Radio Traders' Federation Bulletin No. 6, March/April, 1953.

Philips Experimenter No. 62, Philips Electrical Industries of N.Z. Ltd., Wellington.

CLASSIFIED ADVERTISEMENTS

WANTED TO BUY—Back numbers of *Radio and Electronics* and "A.R.R.L. Handbook" 1945-1950.

FOR SALE—ZC1Mk. I Transceiver with accessories, hardly used; £18 or offer. No. 21 Transceiver, converted to cover 80 metres, with accessories, £12 or offer. Ten-valve 144 megacycle transceiver, 5 watts output; £12 or offer. Many radio parts. write for particualrs. A Gill, off Beach Road, Foxton Beach.

FOR SALE—New R.1155 all-wave aircraft receiver, perfect order. What offers? Collett, Box 15, Oamaru.

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TRADE WINDS

PYE TV SET FOR S.M.T.C.

From Left to right—Mr. G. A. Wooller, Managing Director, Pye (New Zealand) Ltd., Mr. H. M. Scott, Principal of Seddon Memorial Technical College, Auckland; and the Hon. Mr. R. A. Algie, Minister of Education and Minister in Charge of Broadcasting.

The occasion was the presentation by Pye (New Zealand) Ltd. of a complete television receiving set for use by the Television Servicemen's Course.

Mr. Algie in receiving the gift on behalf of the College, paid tribute to the enterprise and generosity of the Pye organization, already renowned for its development of television in Britain and in countries throughout the world.

* * *

MR. LEIGHTON LORD RETURNS TO NEW ZEALAND

For a period of four and a half months, Mr. Lord, Managing Director of Philips Electrical Industries of New Zealand has been abroad conferring with Philips organizations overseas and studying the latest electrical manufacturing techniques in factories on the Continent and in Great Britain.

On his return to New Zealand on 19th May he was accorded a warm welcome at a cocktail party attended by executives and staff of the Philips Company. In the photograph, from left to right, are Mr. J. H. Brookes, representing the overseas management, Mr. T. G. Morgan, member of the New Zealand Board of Directors, and Mr. Lord, obviously enjoying a happy reunion in Wellington.

Mr. Lord brought back with him extensive plans for the expansion of Philips activities in New Zealand.

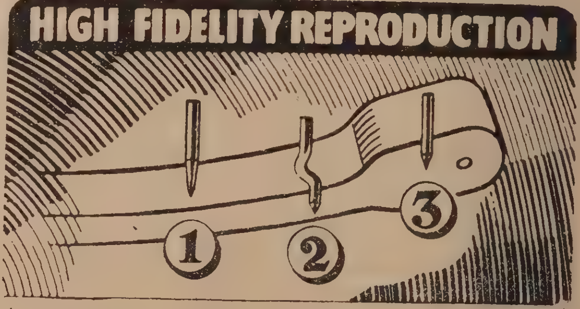
While overseas, he investigated television developments. He believes that the capacity of British manufacturers of television sets considerably exceeds the demand in Britain. Because of this, prices are reasonable, and a very good domestic set can be bought for £60 to £80. All television sets required for New Zealand could be made locally, and there seems no reason why this country could not provide all television receivers required at a reasonable price.

"It was a great pity," added Mr. Lord, "that the Government has not yet seen fit to release to manufacturers the technical standards of the proposed New Zealand service, because, without this information, New Zealand manufacturers cannot commence the preliminary design activities so essential to the development of production prototypes."

* * *

APPOINTMENT OF ASSISTANT MANAGER TO H.M.V. (N.Z.) LTD.

H.M.V. (N.Z.), Ltd., have recently announced the appointment of Mr. S. Heginbotham of the Radiomobile Division as Assistant Manager to Mr. L. Wright. Mr. Heginbotham will continue to control the Radiomobile Division.



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calls for the use of
ST. JAMES *PRECISION* SAPPHIRE NEEDLES

No. 1—Jewel-tipped needles for Crystal pick-ups.

No. 2—"Knee Bend Trailer" Jewel-tipped needles for older heavyweight pick-ups.

No. 3—"Miniature" Jewel-tipped needles for lightweight pick-ups.

THERE'S A ST. JAMES *PRECISION* SAPPHIRE NEEDLE FOR EVERY TYPE OF PICK-UP

SWAN ELECTRIC CO. LTD.
Auckland Wellington Christchurch

This new appointment will relieve Mr. Wright of some of the pressing day-to-day problems, and enable him to devote more time to the additional developments on which H.M.V. are concentrating for better service to dealers.

* * *

A.W.A. HELPS PAKISTAN

Amalgamated Wireless (Australia) Ltd. are the proud manufacturers of the £950,000 worth of telecommunications and broadcasting equipment which Australia is to supply to Pakistan under the Colombo Plan.

This equipment will include broadcasting transmitters and apparatus designed to increase the capacity and range of Radio Pakistan. It will also be used to improve radio communications between West and East Pakistan which are more than 1,000 miles apart.

PYE CLIMBS MT. EVEREST

Not the least vital part of the equipment of the triumphant British Mt. Everest Expedition was the Pye walkie-phones used by the climbers. On these radio receivers they listened to meteorological and other important forecasts, and it can truthfully be said that Pye made a splendid contribution to the success of the expedition.

* * *

£100,000 ORDER

The New Zealand distributors of B.S.R. Products, Messrs. E. M. I. Suppliers, are pleased to announce having received information from Birmingham Sound Reproducers Ltd. that the latter have obtained a £100,000 American order for 20,000 B.S.R. Monarch record-changers.

The "VIKON" Vibrator Convertor for 50 Cycle Power from Batteries

It is common knowledge that there are many districts still without A.C. power—and it seems as if it will be many years before A.C. power reaches all of New Zealand. Meanwhile, many people are often deprived of modern-day appliances, such as radiograms, vacuum cleaners, fluorescent lights, cake mixers, and the like. The "VIKON" Converter offers 230 volts 50 c/s. power wherever D.C. battery supplies are available. Reasonably priced, the high efficiency and low maintenance costs make the "VIKON" ideal for back-country use, caravan or shipboard use—and also for industrial and commercial purposes . . . for

RADIOS AND RADIOGRAMS, TAPE RECORDERS, SEWING MACHINES, BURGLAR ALARMS, ELECTRIC DRILLS, FLUORESCENT LIGHTING, CAKE MIXERS, Etc.

Using The WIMBLEDON 50c/s Vibrator and BEACON Transformers

Standard units available for 6, 12, 24, or 32-volt inputs, giving, for instance, 80 watts for 12 volts and 200 watts for 24 volts.

Standard units adequately suppressed for radio interference.

Details available describing special uses.

High efficiency from standard units. Full load efficiency better than 70 per cent.

Write for information.

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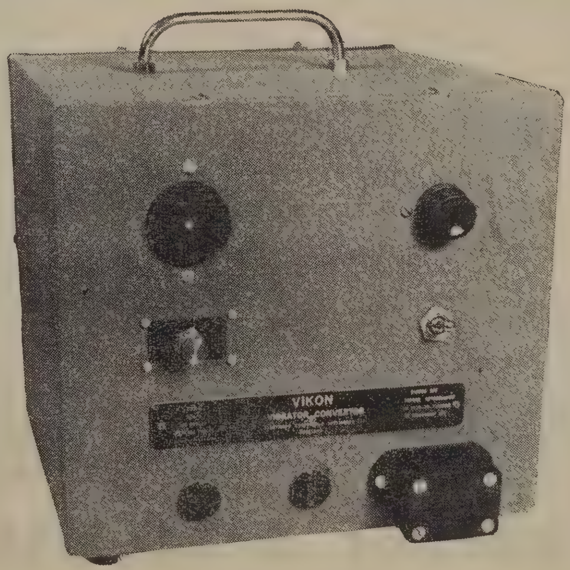

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Book Reviews

Remote Control by Radio, by A. H. Bruinsma, Philips Technical Library.

This little book is not, as the title might lead one to expect, a general treatise on the subject of remote radio control. It is rather a description of two actual control systems which have been put into practice by Messrs. Philips, in their Eindhoven laboratories, in the process of designing and building a display for use at exhibitions and the like. The display consists of two radio-controlled model ships, both quite large, and manoeuvred in a large tank for the edification of the public. The smaller of the boats is fitted with a simple control system giving semi-continuous control for operating the rudder, and a second control channel for stopping and reversing the propulsion motor. This is accomplished by transmitting two audio tones, 50 and 2,000 c/sec., with the former used for the semi-continuous steering control, and the latter for control of the motor. A seven-valve superhetrodyne receiver is used, with each tone operating a relay. The steering and propulsion motors are controlled by these relays, in conjunction with four secondary relays.

The system is quite ingenious, but contains nothing that has not already appeared in the literature of the subject.

The remainder of the book is devoted to a description of the system used to control a second, and larger model ship which is clearly the *piece de resistance* of the display. This time, an eight-channel pulse type of system is used. The pulses are at a rate of 10,000 c/sec., and each cycle of the basic repetition rate is divided into nine periods of 11.1 μsec. each. Each period accom-

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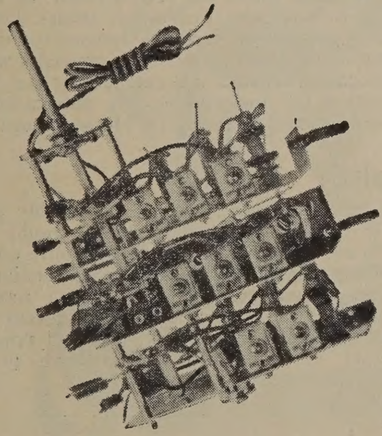
modates a pulse of this duration, and the intelligence is transmitted by changing the amplitude of the pulses.

The first pulse is a timing pulse, and has an amplitude equal to the maximum output of the transmitter. The remaining pulses are arranged as follows: The second one, immediately following the timing pulse, is normally 40 per cent. of maximum carrier amplitude, and is used as a voice channel by modulating its amplitude from zero to 80 per cent. of maximum carrier level. The purpose of the voice channel, incidentally, is to operate a loudspeaker in the controlled boat, so that the operator can describe what is going on to the audience. The remaining seven pulses are used by circuits in the receiver which distinguish between their presence or absence, and thus operate a number of controls for different functions.

As can be expected, the receiver for this system is rather complex, but even so, it comes as rather a shock to find that it uses 40 valves, and a large number of relays and electric motors. For those interested in the subject, the descriptions of these two working systems will be very entertaining, and there is no doubt that a very effective display of remote control has been manufactured. However, the equipment is open to quite considerable criticism on technical grounds. This criticism is justified in a review of this nature, by virtue of the fact that the authors make some claims to illustrate techniques which could be important from the point of view of professional use of remote control equipment. They mention, for instance, the use of radio-controlled scale models of aircraft for evaluating the characteristics of a new design before full-scale prototypes are built, and also the military uses of remote control, which are coming more and more into the technical limelight. For purposes such as this, the equipment described would probably not be very suitable, for a variety of reasons. In the first place, the size and complexity would be prohibitive for all except applications such as this one, where space and weight are not major considerations. The equipment described was obviously designed with little or no thought of these aspects, and while a great variety of functions are controllable, most of them are pure On/Off controls, whereas equipment for professional applications would certainly need several fully proportional control channels. Then again, for serious work it is doubtful whether pulse amplitude control, such as is used in the Philips equipment would be satisfactory in practice, being much more subject to interference, intentional or otherwise, than other schemes which could be used. The large number of valves and relays in the equipment necessitate a battery power supply which is much larger and heavier than could be tolerated for many purposes. Then the use of pulse amplitude control places very severe restrictions on the performance of the receiver, which must have very good automatic gain control if the system is to function satisfactorily at any range. The designers use superheterodyne receivers in spite of the short range over which their equipment has to work for demonstration purposes, in a case where the super-regenerative receiver, operating in the linear



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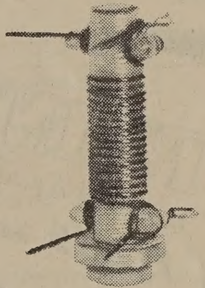

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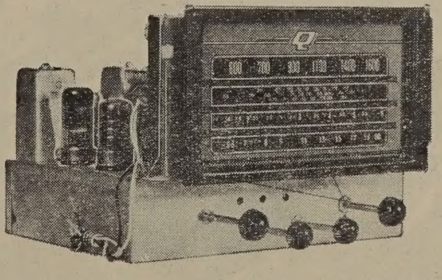

mode would be an obvious simplification. The authors criticize super-regenerative receivers on the score of unreliability, but these days there is no sort of justification for the criticism. It is true that a super-regenerative receiver would have made it difficult to employ the authors' pulse amplitude system, but oddly enough, that is not their stated reason for using a superheterodyne.

However, the authors do not make any claim to present techniques which are in advance of existing other equipment, or even new, and as we said earlier, the book will certainly have much in it that will interest those who have made any sort of study of remote radio control. The book is excellently presented, as is the case with all Philips productions, and even if the translation from the Dutch original is at times a little quaint, readers should have no difficulty in following the text.

New Zealand Radio Traders' Federation Annual Report

The following are the main points from the Annual Report of the New Zealand Radio Traders' Federation, presented by the President, Mr. N. Souper, to the Annual Conference of the Federation held in Christchurch on 19th and 20th May.

Constitution

During the year, the Federation has extended its scope to include household electrical appliances. It was felt that, as most members handle these articles, no good reason could be seen for compelling members to join another association in order to have their interests protected.

Association Proxies

This is the first year in which affiliated Associations could appoint a proxy to the Executive meetings, and I am happy to say that such an arrangement has been of great assistance in the workings of the Executive.

Television

This is probably the most discussed and contentious subject which your Federation has had to handle during the year. Your Executive has done all in its power to combat the often misleading propaganda appearing in the press. Approaches have been made in the Minister in Charge of Broadcasting for a statement on the policy of the Government regarding TV, but it has been impossible to obtain anything other than a non-committal reply. Although the last Annual Meeting decided to publish a brochure for the listeners' benefit, your Executive subsequently realized that this was impracticable, owing to the rapidly changing conditions.

Industrial Matters

The Federation extends its thanks and appreciation to the North Island Radio Manufacturers', Assemblers', and Servicemen's Industrial Union of Employers for their work in obtaining an apprenticeship order for the radio industry. Thanks are also due for their efforts in award matters affecting our North Island members.

Bulletin

During the past year the Federation has published a regular monthly Bulletin containing information of Federation activities, and this has been a means of keeping members up to date with Federation affairs. Unfortunately members themselves have not assisted the editor as much as they might. News notes and comments would be greatly appreciated. Thanks are extended to the Wellington Association for undertaking the publication of the bulletin, with special thought to Messrs. Lord and Young.

Trading Conditions

Though the trade has experienced a reasonably prosperous year, it is felt that manufacturers could give more thought to increasing dealers' margins, more especially in the matter of smaller sets. The production of a four-valve set is unfortunate, for such a receiver shows poor return to the dealer, and often prevents the sale of a more expensive set. As yet, repeated requests to manufacturers to increase discounts have proved unavailing.

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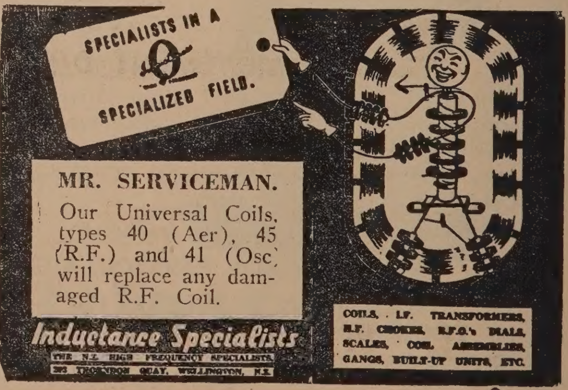

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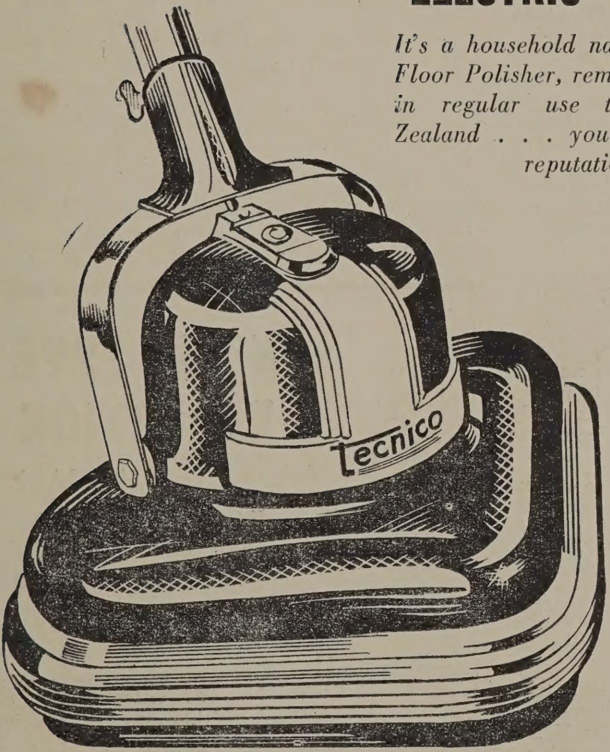

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The Cathode Ray Tube

(Continued from Page 22.)

siderably the cost of cathode ray tubes, which are already expensive enough.

It will be appreciated that the construction of a cathode ray tube calls for very fine constructional tolerances since electrons are "pretty fiddley things" and the percentage of rejects must be fairly high during their manufacture. In countries where television is well established the accent seems to be on bigger and even bigger screens—all of which comes down to more room for error and faults and consequently more pounds shillings and pence!

Philips Experimenter

(Continued from Page 27.)

grid pins of the QQE04/20 are made from shield braid, as are the plate connections for the second ECC91. Apart from these few points there is nothing about the construction that requires special mention, and builders should have no difficulty at all in getting the transmitter going. Output can be taken by simply attaching a twin-lead feeder to the coupling hairpin, but if desired, the hairpin may be tuned by attaching a Philips trimmer to its output lugs. If this is done, the coupling to the tuning line will be found to be much looser, and the practice is recommended if it is found that the untuned hairpin does not give tight enough output coupling unless it is dangerously close to the plate line.

This Month's TV News

(Continued from Page 29.)

"I do not think that we in this country dare contemplate a situation in which we would be forced to undertake the kind of defence to which we almost certainly shall be committed, without widespread knowledge of the electronic arts of defence.

"It would costs millions of pounds and occupy considerable time (of which we should certainly not have a surplus in an emergency) to train the broad pool of skilled artisans that would be needed to design, manufacture, install, service and even operate the electronic equipment that our defences would need.

"This is not mere theory. It is the result of practical experience during World War II," Mr. Fairhall concluded.

The manufacturing capacity and personnel skill television develops is held in high regard by the Governments and Service Chiefs of all countries. This in itself has proven to be a major factor influencing the growth of television which today is operating in some form in 55 countries, with regular services in 19.

Intermodulation Distortion

(Continued from Page 16.)

quite common equipment, and that is more than can be said for harmonic distortion, which on its own is not nearly so useful a thing to measure.

In next month's "Audiofacts" we will continue the story of intermodulation and show how it is measured.

2-Metre Frequency Tripler

(Continued from Page 11.)

only 380 volts on the circuit, as it was the voltage delivered by the only convenient power pace available at the time, and the figures are given below. In case some might think that producing 12 watts of output, with a driving power of six watts is not very great efficiency, it should be pointed out that the stage is tripling, and that for a tripler, the efficiency of the stage itself is quite good.

Plate voltage	380v.
Screen voltage	200v
Plate current	100 ma.
Screen current	9 ma.
Grid current	7 ma.
Total grid bias	—159v.
Output power	12 watts
Plate circuit efficiency	32%

Design for High-quality Audio System

(Continued from Page 6.)

controls are not worth-while anyway. The only point upon which argument can reasonably take place in this respect is on the quest of how many steps are needed. For installations where cost is not considered very important, seven positions on each control should be adequate for the most exacting listener. Accordingly, the block diagram of Fig. 2 gives our idea of the pre-amplifier and response control stages.

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